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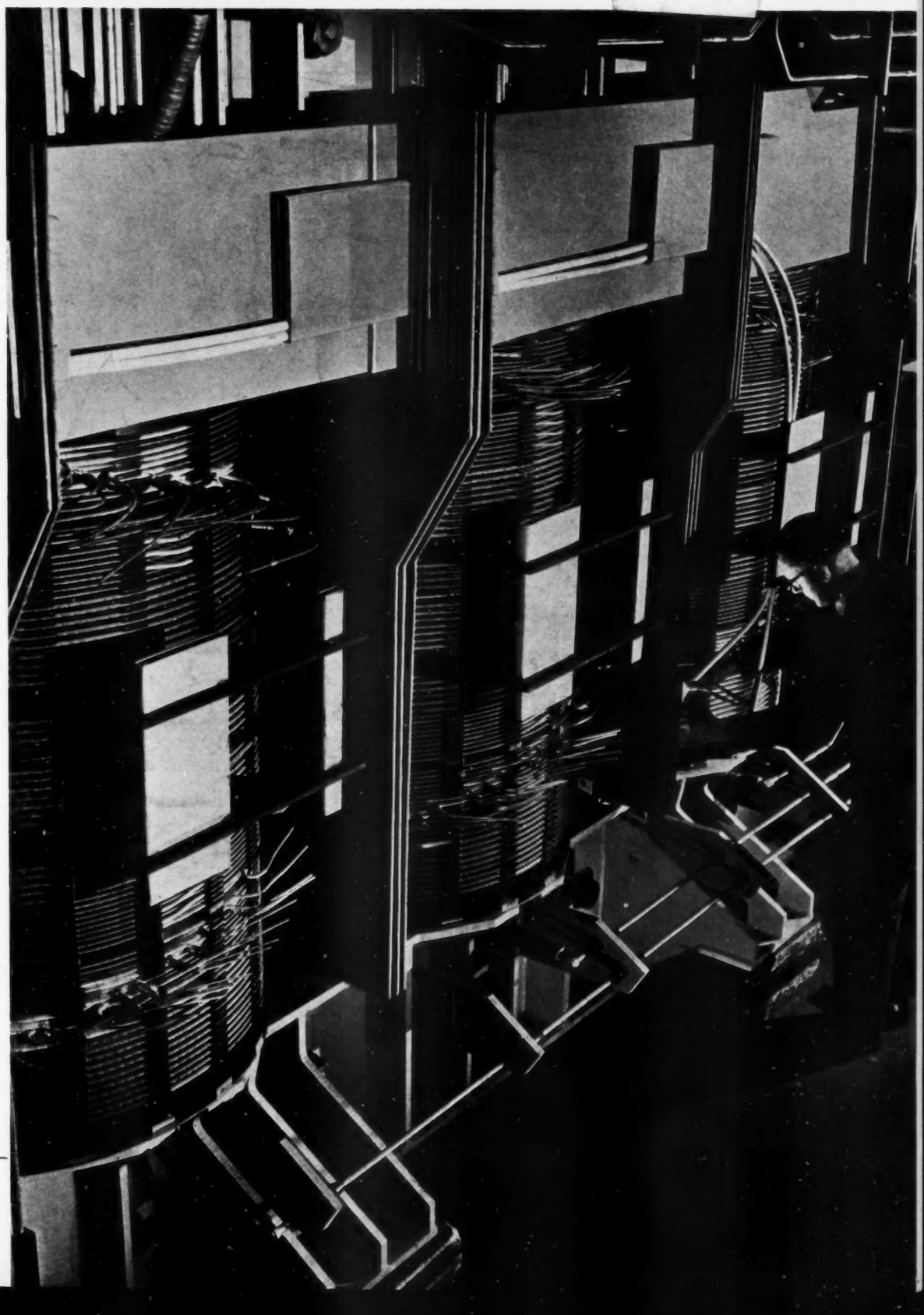

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NALYSIS OF FLOW
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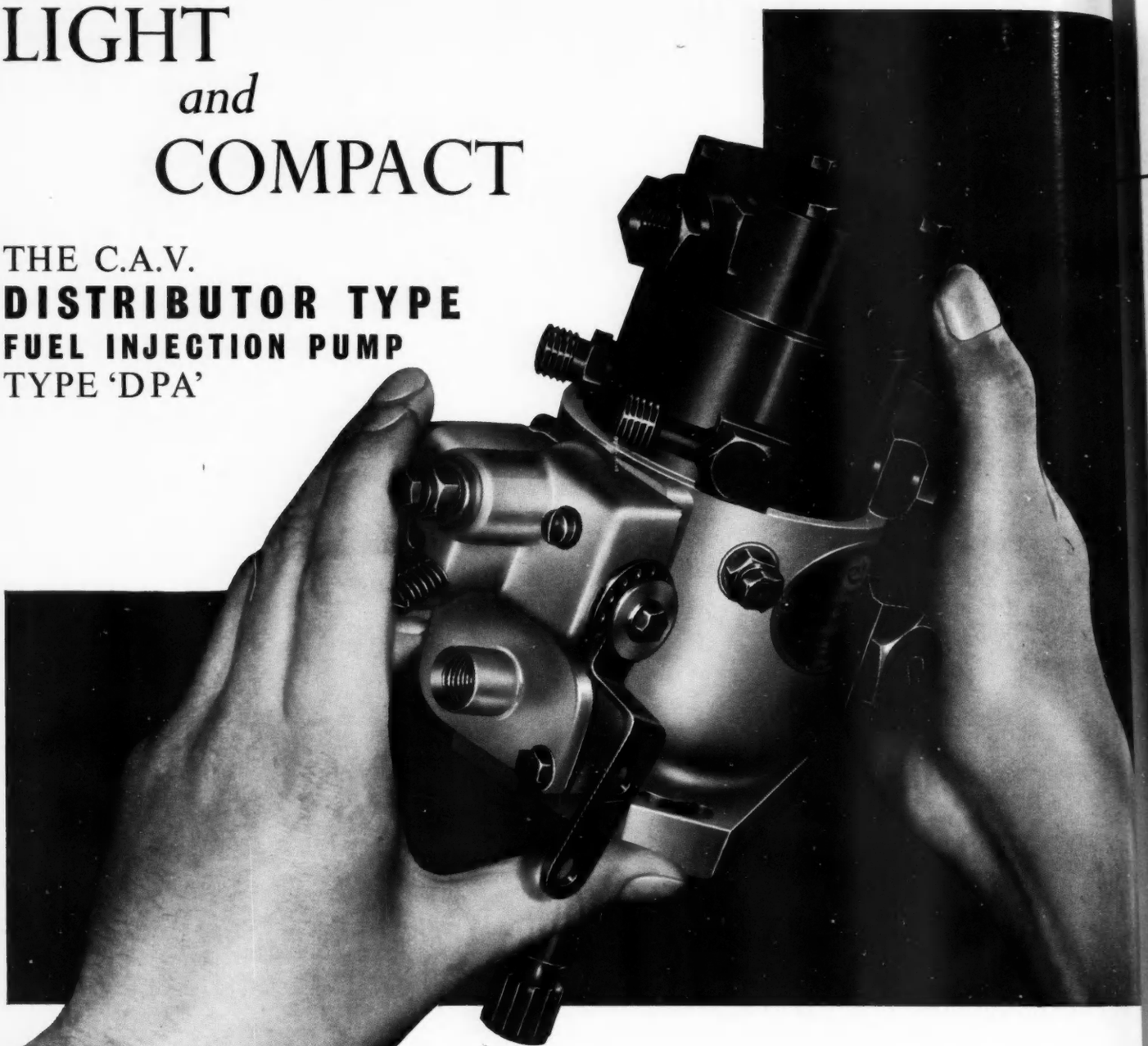

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ENGINEERING

Vol. 187 No. 4847 30 January, 1959 PUBLISHED EVERY FRIDAY

Contents

129 **Leading Article**
Protection Racket

130 **Plain Words**

131 **Letters to the Editor**
Clear Thinking Needed

135 **Companies in the News**

136 **Special Article**
Geneva Distillate: 12—Metallurgy and Fuels

141 **Atomic Review**
For Teaching Purposes

143 **Automobile Engineering**
Freight Across Frontiers
Volkswagen Proving Ground
Heater and Demister

143 **In Parliament**

149 **Meetings and Papers**

154 **Book Reviews**
Constitution of Binary Alloys
Atomic Physics and Human Knowledge

154 **New Books and Trade Publications**

155 **On the Shelf**

157 **Exhibitions and Conferences**

160 **Engineering at Home**
Electric Razors
Easy Lifting
Subscriber Trunk Dialling

. . . . . .

Management

130 Weekly Survey
144 What the Future Holds for:
Coal and Electricity,
Light Electrical Goods, Wires and Cables,
General and Constructional Engineering

132 **Plant and Equipment**
New Locomotives
Capstan Lathe for Seated Operator
Self Regulating Alternator
Ancillaries for Transport
Marine Diesel

142 **The Human Element**

150 **Design**
The Analysis of Flow from Pipe Manifolds
Hydraulic Relief Valves
Power for Black Knight

152 **Research and Development**
Polarisation Reversal in Ferro-electrics
Company's Radiation Laboratory
Regulated High Voltage Supply

156 **Production**
Process Machinery Cuts Flour Mill Costs
Handling Paraffin Wax

158 **Construction**
High Velocity Air Conditioning Permits Building Economy: Noiseless Dual Duct System Now Available.

159 **Metals and Materials**
Sponge Iron
Extruded Aluminium Grating
Polyester Dough
Russian Welding Translation

Protection Racket

THE strategy of business competition in the United States employs, at least where foreign competitors are concerned, some doubtful weapons. It is sad to see responsible members of the American heavy electrical engineering industry emulating their normally more clamorous colleagues. The rejection of English Electric's bid to provide two turbines for the Greer's Ferry hydro-electric project has brought out into the open the campaign which the National Electrical Manufacturers' Association has been waging against the British industry.

In spite of the success of one or two foreign firms in obtaining orders, the level of imports of power equipment in the United States is still a small fraction both of domestic production and exports. According to evidence produced by the British-American Chamber of Commerce, imports in 1956 amounted to only $99 million compared with total United States sales of nearly $21,000 million; while the value of exports was over twelve and a half times that of imports. This is occurring at a time of continuously expanding installation of generating capacity, so that during the short period in which foreign competition has operated, the business of US manufacturers has nearly trebled.

Finding themselves baulked in their arguments that imports were a serious threat to employment in their industry, which is at present protected by a 12 per cent price differential in areas where unemployment is high, as against a 6 per cent differential elsewhere, the American manufacturers have entered upon an undignified attempt to " knock " the British industry. In evidence before congressional committees and to the Office of Defense and Civilian Mobilization, they have claimed that foreign power-plant is unreliable and cannot be adequately repaired and serviced. Attempts to prove the former are based on misleading statistics purporting to show the relative percentage of " outages " in the American and British generating industry, supported by propaganda high-lighting failures in foreign equipment.

The truth is that there are certainly as many failures in American-built plant as in that of British manufacture. It is ironical that the leading American company, which secured the turbine contract for the Chief Joseph dam in 1955 in the face of English Electric's lower bid, has been arraigned by the US General Accounting Office for supplying the Tennessee Valley Authority with 14 defective power generators. In an industry in which technical progress is so rapid, only the most conservative customer can expect to buy plant in the operation of which all difficulties can be avoided. The charge that British equipment cannot be adequately serviced in North America, neglects completely the fact that the two main British companies concerned, English Electric and Ferranti, both control substantial manufacturing resources in Canada.

But no one believes that these arguments are other than a screen for a protectionist lobby. This must be considered against the background of the considerable liberalisation of American trade which has taken place since the war and the continuous fight which the Administration has carried on with those industrial interests who have tried to reverse this policy. The Greer's Ferry bid was a test case for the Administration in the interpretation of the new national security clause written into the " Buy American Act "; but it is not necessarily the case that all future issues will be determined the same way.

British manufacturers remain confident that, given reasonable opportunities, they can continue to do business in the United States because their prices are substantially lower. Nevertheless there are some new factors which may strengthen the protectionist case. American costs in non-mass-production industries appear to be rising relative to those in other industrial countries. For the first time since the war serious unemployment has occurred in some major industrial areas. Under these circumstances political pressures will overcome the niceties of economic doctrine. The present outcry from Lancashire bears witness to the universality of this behaviour. It is not necessarily doctrinaire to point out that a reduction of imports of cotton goods will reduce our exports of machinery. In this case the gainer and the loser will be different people. In the Greer's Ferry case it is curious to find that the gainer, the Baldwin-Lima-Hamilton Corporation (which has been selling large amounts of earth-moving machinery in this country), may turn out also to be the loser.

More decisions of this type would make nonsense of the British Government's attempts to liberalise trade and make sterling freely convertible. If dollars cannot be earned they will have to be saved, and American exports, whether of electrical equipment or earth-moving machinery, again be restricted. It is to be hoped that some reasonable balance between freedom and protection can be struck which will enable manufacturers to make long-term plans—with some hope that the rules will not subsequently be changed against them.

Cover Picture.—*Winding connections being made on the high-voltage side of a 30 MVA star/delta connected transformer having a voltage ratio of 132/33 kV. The transformer complies with the British Electricity Boards specification T2.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Off-putting is an accomplishment that seems to be achieving a wider and wider vogue. It has even supplanted in the public favour the desire to be "one-up" and "to win without actually cheating." Some poor chap slowly drowning in paper, frantically scribbling reports in his own spidery hand, tapping out scarcely intelligible letters on an antique Remington, has only to make the diffident suggestion that he have a secretary, and he is immediately crushed by the sinister and final words: "Parkinson's Law." The power of these fashionable phrases is enormous and the man who masters them is king.

It is almost as if the mass of human beings were incapable of independent judgment, depending as they do on catchwords coined to guide them. Perhaps it is all part of the mechanism: as soon as people's habits lean too far in one direction someone thinks up a terse but telling slogan to restore the balance. These phrases catch on like popular songs, but also like popular songs go on a bit too long. The technique is not, however, entirely new: popular shibboleths have always been used as calumny or argument—such crushing and conclusive retorts as: "It's contrary to human nature," and "It's been done before."

I think we're too easily turned from our purposes these days, and I'm as bad as anybody. Last year I had an idea for a nuclear reactor fuel element: the suggestion was to screw the fuel rod, uncanned, into a small pressure bottle of some moderating material, say beryllium, and possibly containing some moderating buffer liquid. Being away from the walls of the bottle, the fuel could distort to its heart's content without any danger of fission products escaping. What's more, it should be easier to fabricate a heavy pressure bottle than a delicate and complicated fuel can, especially with an intractable material like beryllium. The bottles could then be built up into a critical reactor like bricks; fuel charging and discharging should also be easy. There were obviously problems, such as heat transfer, which might prove insoluble, but at least the principle was simple. The head of one of the nuclear groups, his chief engineer and several of their colleagues kindly spent the day discussing it with me, but the conclusion was essentially that someone must have thought of it before. So I let it go.

I was therefore pretty wild when I came across a German paper delivered at the Geneva atomic energy conference describing a substantially similar idea. Clearly German genius had independently arrived at the same brilliant answer.

Still, it's a long way from an idea to a commercial proposition. After all, I'm no inventor; I'm only ———

CAPRICORN

Weekly Survey

Blood in the Arteries of India

The magnitude of the task of developing a country the size of India is indicated by the scale of a new road plan recently finalised by its Ministry of Transport and Communications. The plan was discussed at the annual session of the Indian Roads Congress earlier this month. It provides for raising the total length to about 657,000 miles. This figure is stated to represent India's minium needs and when it has been achieved, by 1981, the road mileage will have increased from 0·26 to 0·52 miles per square mile of territory. These figures may be compared with present-day mileages of 3·26 for Great Britain and 1·00 for the United States.

The problems facing India are for the most part on this scale. Speaking in Bombay earlier this month Mr. H. V. R. Iengar, governor of the Reserve Bank of India, stated that the third five-year plan would need to be on a very large scale if it were to meet the country's requirements. Though India would continue to raise the maximum resources possible internally there would be a need for some years to come for substantial foreign assistance. The private sector of industry in India has raised its gross fixed capital formation from an annual rate of below 6 per cent in 1951 to as much as 16·5 per cent in 1957. Certain parts of the private sector in the first half of the five-year plan almost reached their investment target for the whole period.

The development of the capital equipment manufacturing facilities in India continues. For example, Hindustan Machine Tools are now producing precision lathes stated to be of as high a standard as those produced in Europe and they hope in the near future to produce a cheaper range of lathes at prices well below those of imported machines. Figures quoted range from Rs. 14,000 to Rs. 20,000, as against a price for an imported machine of Rs. 29,500.

Indian Institute of Science

The Indian Institute of Science, which is celebrating its Golden Jubilee is the first institution set up in India with the avowed object of furthering advanced research in pure and applied sciences. Its establishment is due to the vision and munificence of Mr. J. N. Tata, and it had further financial aid from both the Indian and Mysore Governments, the latter offering 372 acres of land at Bangalore as a gift for the location of the Institute. The Institute owes its solid foundation to Dr. Morris W. Travers, F.R.S., its first director, and his able colleagues. It started with the departments of electrical technology and pure and applied chemistry. It has since progressed considerably in diverse directions, and today it is concerned with research and training in many branches of engineering, technology and science. Investigations carried out at the Institute have led to the establishment and growth of not a few thriving industries. Its laboratory facilities are made good use of both by private and State-owned enterprises. Its library is one of the best of its kind in the Orient. Since its inception some 3,000 graduates from all parts of India and abroad have received post-graduate training, many of them are holding responsible positions in government departments and industry, not to mention scientific organisations both in India and elsewhere.

Turning to engineering, Professor J. K. Catterson-Smith, M.Eng., M.I.E.E., pioneered instruction and research in electronics and electrical engineering in 1923. The aeronautical department was founded in 1943. It has six wind tunnels and works in close liaison with the local Hindustan Aircraft Factory. The internal combustion engineering section has facilities for training students in the theory, design and manufacture of such engines and for research. Engine testing facilities cover a range of 5 h.p. to 1,500 h.p. and speeds of 500 to 5,000 r.p.m. A well-equipped fuels and lubricants laboratory is a recent addition. Amenities are available for testing large compressors, gas turbines and combustion chambers. The power engineering department has four sections dealing respectively with electrical, high-voltage, mechanical, and civil and hydraulic branches. It has the one and only a.c. network analyser in India, and it is being put to good use. The mechanical section affords post-graduate training to engineers in design, operation and maintenance of thermal power stations. It has a modern 600 kW steam plant for practical field training. The civil and hydraulic section coaches engineers in the design and planning of large multi-purpose projects. The high-voltage section is equipped with (1) a three million volts, 50 kW impulse generator; (2) a 200,000 ampere, 30 kW impulse current generator and (3) three testing transformers each of 50 cycles, 1,000 kVA, 2,300 V/350,000 V, capable of being put on cascade to obtain 10,050 000 volts at power frequency. In the electrical communication department, the analogue computer (PREDA) was set up by Professor V. C. Rideout in 1954. It is being used to solve a number of mathematical problems for several departments of the Institute. There is little doubt that the Indian Institute of Science will continue to serve the country, as well as its neighbours, as a leading centre for advanced instruction and research in science and engineering.

Local Attractions

Last weekend the Board of Trade sent out a letter to 60,000 managing directors drawing their attention to the facilities which are available for setting up new factories in areas designated under the Distribution of Industry (Industrial Finance) Act, 1958. In the past the most impressive results have been obtained in attracting industry to special development areas either by special services at attractive prices offered by trading estates or by mild forms of Government direction, such as the withholding of industrial development certificates in certain areas, including London.

The new Act covers not only what were known before the war as the "special areas but also parts of Devon, Hampshire, Kent, East Yorkshire and East Anglia. It is not surprising that some small areas hit by the the recent trade recession have also put in a plea for special treatment. Among these is Corby in Northamptonshire, which is heavily dependent upon the local steelworks. The main areas, however, remain Northern Ireland, the industrial belt of Scotland, South Wales, Tyneside and Lancashire. The Act covers a good many new areas, including the Highlands and North Wales, neither of which have significant industrial opportunities to offer. The special inducements have, therefore, been made available over as wide an area as possible and the intention is to help not only the main depressed industrial areas but also localities with specialised industries or services, such as the hotel and catering trade in certain depressed coastal towns, where special help might offer a stimulus without attracting new industries.

The Act requires the Board of Trade to be satisfied that if a loan of grant is made, the financial assistance is for a purpose likely to reduce unemployment. The Development Areas Treasury Advisory Committee advises the Treasury whether an annual grant or a loan is the more suitable form of help in particular cases and sometimes it may recommend both. The Treasury has to be satisfied that the firm

applying cannot obtain capital elsewhere "on the requisite terms." This phrase means the terms which are needed to enable a particular undertaking to have a reasonable chance of success in the place proposed. In other words, the Act permits of help being given where establishing or expanding a business in one of the scheduled areas might increase the difficulty of raising capital.

It is apparent that the Act has been drawn up to cover much more than the attraction of new industries to highly industrialised areas dependent on a few heavy engineering or metal forming concerns. Nevertheless, these last remain the core of the problem. It is important for small areas in other parts of the country to be eligible for special help but, since the object of the Act is to reduce unemployment, the test of success will be in Northern Ireland, industrial Scotland, South Wales, Tyneside and Lancashire.

Everybody Knows

The achievement of effective internal communication of all types of information and the organisation of budgetary control within a rapidly expanding concern was the central theme of the second management conference held by the Solartron Electronic Group. It was held at the Technical College, Farnborough, and attended by some 120 managers and supervisors at all levels of management. The chairman and managing director, Mr. John Bolton, sketched the growth pattern of the group; five years ago they employed 110 people and had an annual turnover of £95,000—today employment has risen to 1,200 and turnover to £2 million. In five years time, these figures are expected to have swollen to 3,250 and £7·5 million, respectively.

The purpose of the conference was to hold a lively discussion of the problems the firm are facing. In the "happy-say-what-you-like" atmosphere, which Solartron consider one of the main factors in their success, a number of definite proposals were made. The reasoning behind what some may consider a somewhat theatrical approach to very down-to-earth problems is based on the belief that a system is only as good as it is understood by the people concerned with its operation.

The conference heard papers by Mr. George Sanders, director of production, on "the movement and co-ordination of the assets and liabilities of a complete manufacturing and selling concern." The chief accountant, Mr. A. G. Scott, talked on "how accounts help everyone to control their particular piece of activity," and Mr. Bowman Scott, the personnel director, discussed how it is possible to communicate effectively with the least effort. Two films and a speech-free dinner ended the proceedings, which appeared to be based on excellent public relations, internal and external.

Targets for Hungary

Information on the state of Hungarian industry is scanty. Even now, such figures as are released follow the customary Communist pattern of laying down targets of what is to be done or of giving percentage increases without figures in the base year. Nevertheless, the latest information released is of some interest.

Hungary plans to export complete high-capacity power stations, canning factories, telephone exchanges and studios for radio and television stations. Production in telecommunications is to go up by 20 per cent, and the production of high-voltage equipment by 16 per cent. The State railway factory is to change over from making steam engines to diesels and 50 per cent of ships built in 1959 will also be diesel-powered. The Ozd Martin Steelworks in Northern Hungary is to be rebuilt and the building of a ball-bearing factory is to be completed this year. At the Lenin Foundry Works the furnaces are to be fired by methane gas imported over the 227-mile pipeline from Romania.

A considerable increase is planned in the production of consumer goods. How much this means in absolute terms is problematical but the news that 15,000 radio sets of 20 different varieties are to be produced is comment enough.

Seeing is Understanding

The use of industrial films and film strips as an aid to training is now widely established in industry. With the growth of the technique has gone an increase in the library resources and among these is the Visual Aids Information and Advisory Service, which is part of the British Institute of Management's information service. This service offers expert advice to subscribers on making industrial films, how to use them and where they can be obtained. Its register of films and film strips is now in 35 sections, ranging from advertising and atomic energy through the alphabet to work and methods study.

Where there are enough films of good quality of interest to management the information summary is available. There are two of these at present, one on work study and the other on human relations, while two more are in preparation. These are on selling and sales techniques and on films for use in the office.

There should be a big future for films in training schemes for commerce and industry. They can, of course, be misused and they have to be fitted into a scheme of work. Their main value is as a contrast to teaching by lecturer or discussion, and as a means of illustrating succeeding processes or developments in human situations against a realistic background.

Rough Roads

Local subsidence, cracked and crumbling surfaces and uneven joints have always been troublesome on roads. If concrete roads suffered more in the past from these defects than macadam, they have the advantage that they can be roughened to provide a better grip when ice is about. Tar macadam has tended to polish when wet, increasing the tendancy to skid. The lighter colour of concrete, compared to black-top, makes for better driving at night, the glare of headlights being less off concrete than macadam. There is still no characteristic to outweigh availability as the deciding factor when selecting the material with which to build a road.

In Germany, during the great period of autobahn construction, difficulty was experienced in getting uniform consolidation below the slab. Pronounced joints, with subsequent cracking of the slab, were a frequent occurrence. High vehicle speeds were possible because of the layout: the elimination of side connections and the use of clover-leaf junctions—not because of a notably fine riding surface. American experience has been much the same. Moreover, for these relatively rough riding conditions vehicles are given a soft suspension.

Here in Britain we have long had what has been called, somewhat acidly, the finest secondary road system in the world, and vehicles have had hard suspensions. At long last the authorities circumscribed all the objections raised against motorways for this country. Because, 47 days after it had been opened, Preston bypass had to be closed for repair, all manner of suggestions have been made to abandon the proposed road programme. Because less than one half of one per cent of the road surface has broken down under frost action and heavy traffic, harsh criticism has been levelled against all connected directly or indirectly with its construction. The Preston bypass has been built with a water-bound macadam, laid cold, and has temporary surface. It is the first of its kind in Britain. What has been found out is that experience is bought by practice, not experiment.

Letters to the Editor

CLEAR THINKING NEEDED

SIR, In his letter in your 23 January issue (page 99), Mr. M. H. Bradshaw-Jones was kind enough to comment that the material in the Industrial Welfare Society's book *Successful Suggestion Schemes*, concerning the operation of suggestion schemes, is excellent, but makes two criticisms of a statistical appendix for which I was responsible. His arguments seem most cogent and I trust that you will allow me to make it clear to your readers that he is tilting at windmills of his own creation, except for the figure of 9·3 per cent on page 28, which should read 11·8 per cent.

The first criticism is that we have compared the results from 208 firms in 1957 with those from 238 firms in 1955; indeed that only 190 firms are common to both surveys, and that, therefore, the results are valueless and that we are guilty of muddled thinking.

This is at first sight a reasonable objection, but, in fact, the results in both years are very heavily weighted by the results of the large firms, and the large firms are common to both surveys. The "ins" and "outs" were mostly small firms which made little difference to the gross results. This is stated quite clearly in the text.

The second criticism is that there is no point in comparing the rate of progress in England with the rate of progress in the United States, since the latter is so far ahead. We agree—and we made no such comparison. Don Quixote is really at it this time! The full National Association of Suggestion Systems table is printed for anyone to make whatever comparison he chooses; the most obvious fact is that on these figures American firms get far more acceptable suggestions per 100 workers than we do.

Mr. Bradshaw-Jones then moves from the statistical and factual—which he first states are his only interests—to the subjective. He states that "there is an air of complacency in the IWS booklet." This I just cannot see. I entirely agree that there is no cause for complacency. The vast majority of schemes that do exist here are still not working well, and there are a great many firms in this country which should, but do not, have suggestion schemes. This is all stated clearly in the introduction.

Could it be, however, that he has misinterpreted our hopefulness? We are hopeful because the trend seems to us to be upwards, slow though the improvement is. We are hopeful because we now have clear evidence of successful schemes in most industries and in firms of widely different sizes. We have, therefore, models which other firms can emulate. We are hopeful because the results of the IWS Suggestion Schemes Group discussions have: (*a*) helped members to improve the results in their own firms, and (*b*) given us an opportunity to sift out the reasons for success. We are hopeful because at last there are publicity posters available at an economic price to assist firms. We are hopeful because of the growing number of inquiries which we receive on the subject. But we are not complacent.

Perhaps your readers would care to judge for themselves.

Yours faithfully,

WILLIAM DURHAM,

Assistant Director, Industrial Welfare Society.
48 Bryanston Square, London, W.1.
26 January, 1959.

SIR, In reply to Mr. M. H. Bradshaw-Jones's letter published on 23 January, may I make one or two comments?

My letter to you, published on 16 January (page 67), was concerned with Mr. F. Porges's attack on *one aspect only* of the statistics printed in the Industrial Welfare Society's booklet *Successful Suggestion Schemes*—the yardstick used to measure the response rate of employees. This is about the only part of the comparative statistics which Mr. Bradshaw-Jones has *not* seen fit to demolish as meaningless! I can

Continuing

Letters to the Editor

only assume, therefore, that he accepts my comments about this in my reply to Mr. Porges.

Secondly, I am no statistician, and have no intention of entering the argument about the solidity of the IWS figures. In any case, I understand that the IWS itself is writing to you on this aspect of the booklet. One general comment, however, I *would* make on Mr. Bradshaw-Jones's remarks. There is all the difference in the world between *his* criticism, based on a careful study of the figures and Mr. Porges's criticism, apparently based on reading one sentence of a short review! Mr. Bradshaw-Jones need not fear, therefore, that I shall consider him offensive. As he says, he has "tried to keep the subject on a factual level." It was the evident lack of factual criticism which led me to describe Mr. Porges's remarks as having offensive implications.

I am glad, incidentally, that Mr. Bradshaw-Jones considers the main part of the booklet to be "excellent material," as this, after all, contains the most important information. The booklet, surely, is going to be of most value to firms who have no suggestion schemes, or only poor schemes, and I cannot help feeling that they will not be particularly interested in statistics, meaningless or otherwise. This is not to say for a moment, of course, that if the statistics *are* valueless, they should continue to be used, but there is a danger, I think, of becoming so involved in argument about them, that the primary value of the booklet as a guide to the successful operation of suggestion schemes is overlooked.

Finally, let me hasten to agree with the last points made by Mr. Bradshaw-Jones. (1) The formation of a British equivalent of NASS would undoubtedly be beneficial, because it could concentrate full-time on a subject to which the IWS can, of course, only devote part of its energies. (2) The IWS survey while claiming some improvement over that of 1956 still indicates clearly the feebleness of most schemes, even among those firms contributing to the survey. This is obviously a management weakness which those of us concerned with suggestion schemes must continue to spotlight in every way we can—in correspondence such as this, for example!

Yours faithfully,

R. A. SHEPHERD,

Chairman, IWS Suggestion Schemes Group.

289 Corbets Tey Road, Upminster.

26 January, 1959.

LIBRARY OF COMPUTER PROGRAMMES

Libraries of subroutines and programmes for Ferranti computers are being compiled and are continually being added to. Ferranti Library Services exist to distribute information about these programmes, and to make it possible for every owner or user of a Ferranti computer to utilise them to the full. There are three categories of programme: firstly, subroutines to be incorporated into users' programmes; secondly, complete programmes which may be used on their own or in conjunction with other programmes; and thirdly, general purpose programmes into which the user incorporates his own subroutines. In the case of the Pegasus, the library service has been fully established; those for the Mercury are now being established, although the only documents so far available are preliminary specifications. There are also to be libraries for the new Perseus computer.

Every purchaser of a Ferranti computer is automatically made a member of the appropriate library service. Others interested should apply to Ferranti Limited, London Computer Service, 21 Portland Place, London, W.1.

Plant and Equipment

NEW LOCOMOTIVES

Locomotives completed recently by the Yorkshire Engine Company Limited, Meadow Hall Works, Sheffield 9, include an eight-wheeled, Bo-Bo, narrow gauge adaptation of their "Janus" 400 h.p. diesel-electric locomotive and a new diesel-hydraulic shunter.

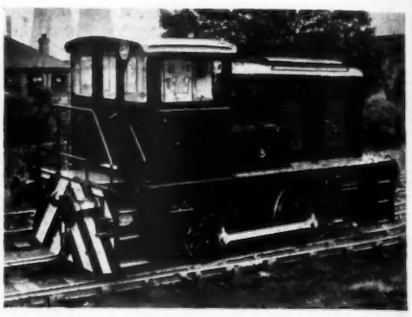
Designed for hauling ore trains on a 30-mile long 3 ft 6 in gauge line in British Guiana, the larger locomotive is the first of three being built to the order of the African Manganese Company (Mines Management) Limited. It will haul a maximum load of 370 tons with a gradient of 1 per cent against it, and has a maximum speed of 30 m.p.h. Two Rolls-Royce C8NFL engines, rated at 202 h.p. each at 1,800 r.p.m., supply the power to two BTH generators, and the final drive is by four BTH double-reduction traction motors. The locomotive, which weighs 48 tons, has a maximum tractive effort of 28,000 lb.

Designed for export to British Guiana, the Yorkshire Engine Company's Bo-Bo diesel-electric locomotive is of 400 h.p.

SHUNTER

The smaller locomotive extends the Company's range by providing a 28 ton diesel shunter for lighter duties. It is powered by a Rolls-Royce C6NFL engine, and a Rolls-Royce Twin Disc torque converter, the power unit being set in the frames at an angle to couple directly to a David Brown axle-hung double reduction gearbox incorporating power reversing. This direct drive to the rear axle simplifies the transmission layout considerably and dispenses with the jackshaft. The engine is rated at 178 h.p. at 1,800 r.p.m., and the maximum tractive effort of the locomotive is 16,400 lb.

Wheel arrangements are 0-4-0 or 0-6-0 to choice, the power equipment and transmission being identical in both cases; the overall length, of course, is greater in the six-wheeled arrangement, but only by 1 ft. The locomotive can be adapted for any gauge from 3 ft to 5 ft 6 in. A totally enclosed driving cab is fitted, and the driving controls are duplicated so that the locomotive can be driven from either side.



A 170 h.p. diesel-mechanical shunter extends the Yorkshire Engine range in the lighter duties group.

CAPSTAN LATHE FOR SEATED OPERATOR

Designed for a seated operator, the "Accuratool" capstan lathe is available with a range of accessories.

Specially designed for a seated operator, the new "Accuratool" capstan lathe, marketed by Dowding and Doll Limited, 346 Kensington High Street, London, W.14, is available with alternative headstocks for bar work up to $\frac{5}{8}$ in or $\frac{13}{16}$ in diameter. With either headstock the lathe will accommodate second-operation work up to nearly 3 in diameter. The effective length of the bed is 24¾ in.

All the controls are arranged in a natural position for the operator, the push-button control box on the front of the headstock giving finger-tip selection of spindle speeds, forward and reverse. A choice of two standard spindle speed ranges is available, 8 speeds from 75 to 3,000 r.p.m. or 16 speeds from 39 to 3,000 r.p.m. Several alternatives can be provided and for certain simple applications the gearbox can be dispensed with, thus reducing the cost of the machine.

Several items of interchangeable equipment are available for use on the lathe. They include an air-operated collet which can be used in conjunction with an air-operated swing stop, a normal or an air-operated turret slide, and a drilling and boring tailstock which is interchangeable with the turret slide. A lever-operated compound slide, which can be swivelled to 45°, is available for many different second-operation jobs. Further additional equipment includes a lead screw operated cross slide and a thread-chasing attachment. An air-operated spindle brake is also available.

SELF REGULATING ALTERNATOR

The self-regulating alternator that has been developed by W. H. Allen Sons and Company Limited, Bedford, uses the system originated by Arthur Lyon and Company (Engineers) Limited some years ago. The equipment is intended primarily for marine applications where comparatively large squirrel cage motors have to be started, but is also suitable for general use. It is intended initially to manufacture two ranges, approximately from 200 to 1,500 kW (or above if required) for turbo-alternator sets running at 1,500 to 1,800 r.p.m., and from 100 to 1,000 kW for diesel alternators in the speed range from 250 to 1,200 r.p.m.

The complete excitation and control circuit is shown diagrammatically in Fig. 1. The alternator itself follows the existing marine design of the firm but the rotating exciter is replaced by a static system in which there are both shunt and series elements combined to give an excitation corresponding to constant voltage output. The principle is thus that of phase-compensated-line-compounding, the shunt transformer providing the no-load component and the series transformer the on-load component. The vector sum of the transformer outputs is the supply to the main excitation rectifier, and the ballast reactor provides some compensation for the temperature variations of the alternator field and also assists the transient voltage response. Fine control is obtainable by adjustable air gaps on both the ballast reactor and the series transformer.

To obtain extremely accurate voltage level control, an automatic trimming unit is included. This comprises a simple automatic regulator of the static magnetic amplifier type whose output controls the impedance of a saturable control reactor connected in parallel with the ballast reactor. Thus the total impedance of the shunt transformer circuit is varied slightly in response to any slight variation in voltage detected by the regulator, and the steady state voltage is maintained automatically within the usual $\pm 1\frac{1}{2}$ or 2 per cent of normal. The trimming control can also be used to introduce a conventional quadrature droop compensation for parallel running of machines. A manual control circuit is included to guard against failure of the automatic trimming circuit. The inherent regulation of the system without the trimming circuit is about ± 4 per cent. Hand operation in place of automatic improves this somewhat but does not, of course, give the exactness of the automatic operation.

The voltage dip resulting from the sudden application of load is shown in Figs. 2 and 3. A marine alternator of 350 kW rating at 450 V and 1,800 r.p.m., was the test machine and the loads applied were wholly reactive, that is, at zero power factor. The tests were intended to reproduce the condition of suddenly starting up a squirrel-cage motor without any special starting current limiting devices; under these conditions the starting current is virtually the short circuit current of the motor. As will be seen, the response is very quick and the steady state achieved rapidly. The makers state that in general if a dip of 15 to 20 per cent is acceptable, then motors having horse-power ratings up to half that of the alternator can be direct started, provided that their starting currents do not exceed four times full load.

Since most alternators have a very low residual voltage to initiate excitation on starting up, a small permanent magnet pilot exciter is provided. Its power does not exceed 200 W even for the largest alternator in the range, and its sole purpose is to establish a sufficient terminal voltage for the main excitation circuit to become self-sustaining. Once the " self-excited " voltage from the main rectifier exceeds the voltage from the pilot rectifier, the output of the latter is blocked, and the pilot thereafter runs as if on open circuit.

Apart from the advantages of rapid response and good steady state control, the system offers a saving in alternator dimensions by the absence of the rotary exciter. The room required by the pilot exciter is very small and the control panel can be placed at a point removed from the machine perhaps between it and the main control panel. Also the absence of moving parts (apart from the pilot exciter which is of proved reliability) enhances the overall reliability of the set and reduces maintenance. The inherent high short-time overload capacity is also an advantage, as it guarantees the operation of time-delayed protective devices although it requires the switchgear to be large enough to withstand it.

As mentioned earlier, the system is particularly suitable where large squirrel-cage motors have to be started direct on line, thereby imposing heavy loads at very low power factors. Ships' auxiliaries are typical examples as also are stand-by pump sets. In later models, silicon rectifiers might be used in place of the selenium ones in the prototype, giving a further reduction in size.

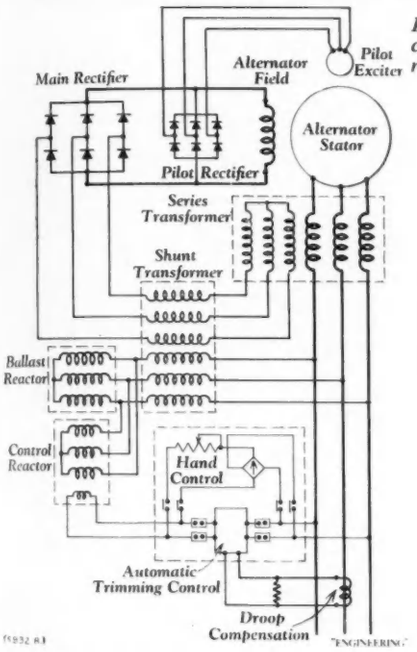


Fig. 1 Excitation and control circuits for self-regulating alternator.

Fig. 2 Voltage response oscillograms (a) from no load and (b) with alternator preloaded at normal full load excitation; all loads being at zero power factor.

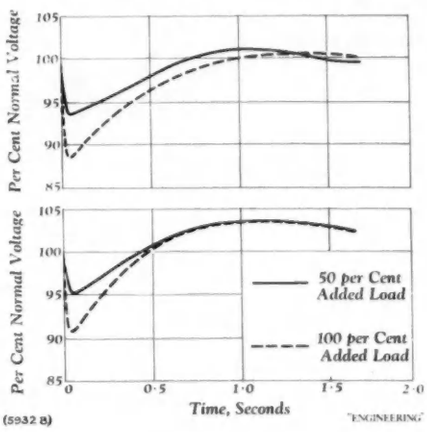


Fig. 3 Oscillogram for direct-on switching of squirrel cage induction motor with standstill short circuit current of 850 A at 450 V. Alternator rating 350 kW at 450 V.

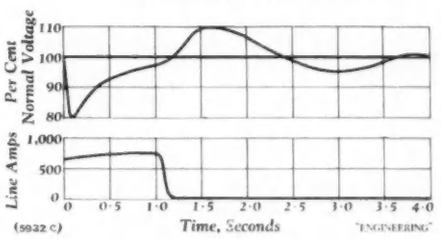
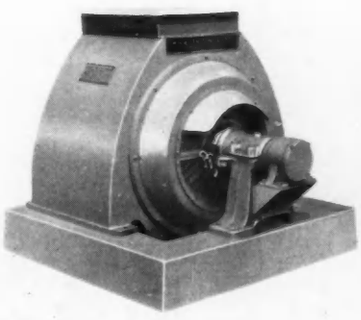
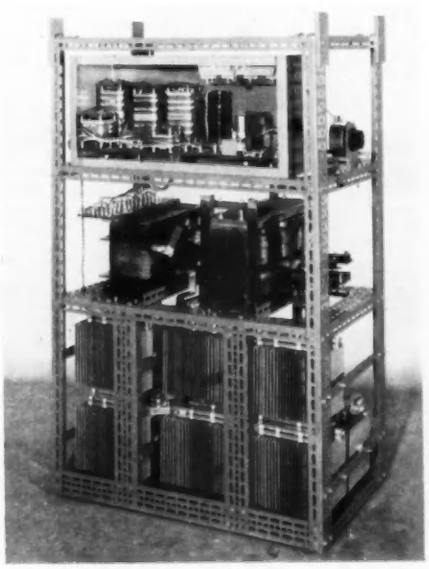


Fig. 5 (right) In the prototype equipment, the control and ballast reactors and the automatic timing control are mounted at the top, and below them the shunt (left-hand) and series transformers. The rectifiers are at the bottom.

Fig. 4 An Admiralty design alternator shows the relatively small size of the pilot exciter.



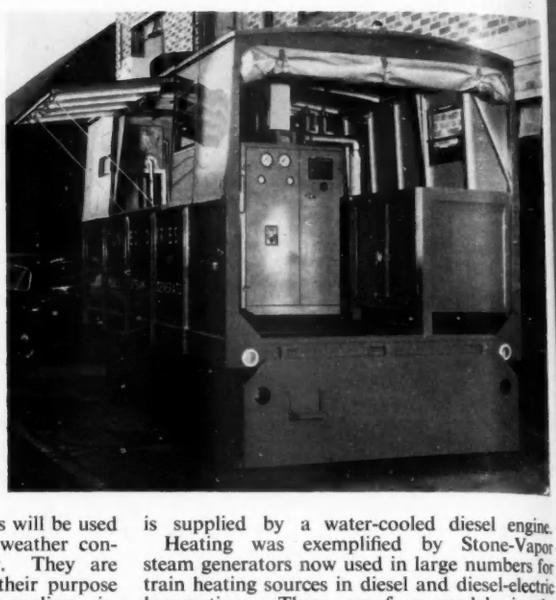


Continuing **Plant and Equipment**

ANCILLARIES FOR TRANSPORT

A small exhibition arranged recently by J. Stone and Company (Deptford) Limited London, S.E.14 (which for convenience was held at Charlton), brought together many of the items that the firm are now producing for the transport industry and, particularly, either as main or sub-contractors, for British Railways. Heating, ventilating, and power equipment were included.

Stone are now making the Mekydro transmission unit that is being fitted on some diesel locomotives and railcars. The main advantage of the unit is that it can be used with a light-weight fast running diesel engine and in conjunction with an automatic four-speed gearbox, the torque convertor can always be run at or near its optimum speed. This gives a very level power curve. An example of overspeed control was the Stone-Smith unit as fitted to the Warship class of locomotive used on the Western Region. In this particular version the brakes are automatically applied should the locomotive speed exceed 120 m.p.h.



Mobile steam generating plant.

For the overhead system of electrification that is being installed by British Railways, Stone are making the Faiveley pantograph. This is the type that has been developed by the French Railways for speeds up to 100 m.p.h. and has only one set of side arms, making it appear unsymmetrical. It is, however, aerodynamically symmetrical, as tests in a wind tunnel have shown. It is lifted by an air motor against sets of springs that come successively into operation to balance the mechanical forces, and fails to safety by retracting if the air pressure should fail. Corrections are automatically made for changes in height of the catenary while maintaining the contact pressure constant at 20 lb ± 2 lb. The collector is rated for 900 A at either 6·25 kV or 25 kV. Another Faiveley product on show was the intercoach coupler suitable for use up to 3,000 V d.c. at 400 A. The Stone-Kheops coupler for intermediate voltages (up to 600 V at 320 A) was also on view.

To provide the auxiliary power needed in the diesel multiple-unit Pullman trains, Stone are making (as sub-contractors to Metropolitan Cammells) diesel-alternator sets in which a 190 h.p. Rolls-Royce engine drives a 120 kW Stone alternator. Two of these sets will be used in each train set, but in normal weather conditions one will act as standby. They are mounted on the underframe and their purpose will be to supply lighting, heating, cooling, air-conditioning and refrigeration units. There was also displayed a lighting generator developed for railcar applications.

A large part of the exhibition was devoted to ventilation and air conditioning equipment. There was a forced ventilation system using steam and/or electricity for air heating, designed for railcars in territories where the emphasis is on heating rather than cooling; an air conditioning equipment for the luxury train sets now being built for BTC; and a refrigeration set for use on road trailers or railway wagons. The last is capable of providing storage temperatures between 60° F and 0° F in any vehicle body that does not exceed 30 ft in length. Power is supplied by a water-cooled diesel engine.

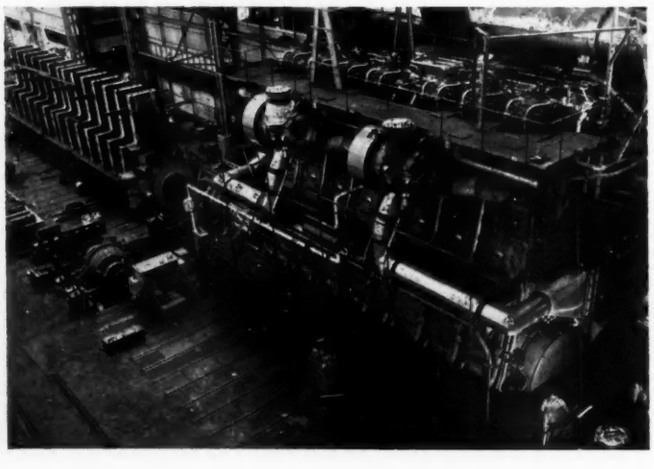
Heating was exemplified by Stone-Vapor steam generators now used in large numbers for train heating sources in diesel and diesel-electric locomotives. There are four models in the standard range: producing from 1,000 lb to 4,500 lb of steam per hour in the pressure range from 70 lb to 275 lb per sq. in. A different application was the mobile plant shown. This consisted of a trailer in which was mounted a boiler with steam connections to the exterior so that the unit could be brought to site and coupled up to an existing plant, taking the place of the regular boiler while the latter was undergoing overhaul. The particular unit shown was for United Dairies; steam can be raised in a matter of two minutes from cold so a quickly available standby source is provided. Fuel and water tanks are built into the vehicle so that it is substantially independent.

MARINE DIESEL

The firm of Alexander Stephen and Sons, Limited, Linthouse, Glasgow, S.W.1 (who three years ago completed 200 years of shipbuilding and engineering) have recently built their first turbo-charged Sulzer diesel engine, and invited the technical press to witness part of the trials on it.

The engine is for the "British Fulmar," one of two sister ships being built at Linthouse for the British Tanker Company Limited. It is designed to develop 8,750 b.h.p. at 115 r.p.m. but in normal service it will not exceed 7,750 b.h.p. at 110 r.p.m.

The engine is of the 7RSAD76 type—that is, there are seven cylinders of 760 mm bore and turbo-charged—and works on the two-stroke cycle. It is the version that was originally designed to incorporate a lever driven scavenge pump but subsequent trials have shown this to be unnecessary and it has therefore been removed from the engine. The scavenge air is supplied from the turbo-chargers. The exhaust valves are of the semi-rotary type and are operated by levers from the camshaft. The undersides of the pistons act as scavenge pumps—a feature that is of importance at slow speeds.



A seven cylinder RSAD76 is the first turbo-charged engine to be built at Linthouse.

To supply the seven cylinders there are two turbo blowers, of Sulzer design, one driven from the three forward cylinders and the other from the rear four. Both are of the type with turbine and compressor wheels on the same shaft. Engine speed is controlled by a Woodward type governor and provision is made for varying the injection timing while the engine is running. The fuel is boiler oil and starting is by compressed air. The engine controls are interlocked with the ship's telegraph and the turning gear so that it is not possible for the engine to be run in the reverse direction to that shown on the telegraph indicator or to be started with the turning gear engaged. Automatic stops are also included to guard against failure of the lubricating or cooling oil supplies, or of the cooling water.

Alexander Stephen have also built an experimental Pescara free piston gasifier of the GS34 type. It has been installed in a test house so that experience can be gained in the operation and use of this type of prime mover and for training engineers in its functioning. Full test facilities have been constructed including provision for mounting a turbine unit. The gasifier incorporates an automatic valve which allows the machine to be started against a throttle (or under load) and also permits the output to be cut down to virtually zero power without the use of a pressure blow-off valve. This result is obtained by recirculating a portion of the compressed gas. The recirculating valve can be set to operate at a chosen pressure.

Companies in the News

British Design for US Forces

British know-how has been purchased by an American firm under an agreement announced last week between the Raytheon Corporation and Ferranti Limited. Klystrons, designed and developed by Ferranti, will be made under licence in the United States by Raytheon. A sum of $250,000 is involved in the deal. Two tubes are included: one an oscillator of 15 watts output and the other an amplifier supplying power up to 2 kW at frequencies in the region of 10,000 Mc/s. Both are used in Doppler radar systems.

Development work on klystrons has been carried out by Ferranti over the past six years under Admiralty contract and in conjunction with the Royal Radar Research Establishment at Malvern, which designed the noise measuring equipment necessary for measuring the performance of the klystron. Ferranti claim that the reason for the acceptance of a British—designed klystron—they are intended for use in American military equipment—was due primarily to the very low noise, not yet attained by other valves on the market.

The terms of the agreement provide that Raytheon send a team of engineers to Britain—they arrived early this month—to study manufacturing methods and techniques, and receive from Ferranti Limited manufacturing specifications and drawings.

Parsons Tradition Continued

Appointments by the board of C. A. Parsons were announced last weekend, consequential upon the death of Sir Claude Gibb. Mr. F. W. Gardner, who was deputy chairman of the company, was elected chairman. Mr. H. H. Mullens, the chairman and managing director of A. Reyrolle and Company, becomes deputy chairman, and Mr. G. M. Baker, the general manager, becomes managing director.

Sir Claude Gibb died aboard an aircraft on his way from the United States to Canada. As we indicated in our obituary columns last week (page 100), Sir Claude had laboured tirelessly since the war to maintain the firm's great tradition of overseas trade, and doubtless exerted a decisive influence on his company's magnificent achievements in Canada. In 1952/53 they installed four 100 MW turbo-generators for the Hydro-Electric Power Commission of Ontario at the Richard L. Hearn power station. They are now installing the first of a further four sets each of 200 MW.

Another noteworthy achievement was mentioned in our obituary, namely, Parsons share of the first nuclear plant order for Latina in Italy, for which they supplied three 70 MW turbo-generators to the order of the Nuclear Power Plant Company Limited, which Sir Claude Gibb was instrumental in founding. Parsons currently export half their turnover and have done so since the war. This is a great tradition of export-mindedness which Sir Claude Gibb's successors will strive to upkeep.

Muted Bankers

January is the season of bank chairmen's reviews. For a number of years now they have been, with a few notable exceptions, cautious in tone and dull in content. It might have been hoped this time, after an exceedingly eventful banking year, that more would have broken away from the annual formula of a quick recounting of recent economic history and have spent more of their space on taking a forward view. Many chairmen's statements clearly suffer from drafting emasculation as they ascend the pyramid which leads to the chairman's desk.

Those chairmen who have covered recent international economic events with an eye to future problems, and among these Sir Oliver Franks of Lloyds Bank has been as usual outstanding, have all taken on balance an optimistic view. They have joined an impressive chorus of opinion in America and on the continent of Europe which reiterates that the western world faces an upswing in the trade cycle if it manages its affairs intelligently.

At a time when a number of important innovations have been made in banking practice, that section of the public which uses banking services would have welcomed some thoughts from the chairmen on the future relations of bankers and their clients. It is not without significance in this connection that the latest issue of *Which?* carries a short review of bank charges in Scotland and England. The banks themselves this year have introduced personal loan schemes, committed themselves in many cases to a much bigger stake in hire-purchase business and in one case a personal cheque scheme.

Bid for Perkins

The official announcement last weekend of the take-over bid made by Massey-Ferguson for F. Perkins is a further step towards the integration of the Massey-Ferguson Group, following their decision to purchase Standard's tractor factory and so manufacture their own products "from A to Z." The purchase of Perkins's engine business will give Massey-Ferguson first-class manufacturing facilities, where they will presumably also make the petrol engines now made by the Standard Motor Company.

From Perkins's point of view the offer could not come at a better time. The company suffered a sharp setback in 1957, when a profit of £769,000 was turned into a loss of £327,000 and no dividends were paid. In a recent statement, Mr. Frank Perkins could hold out little hope of a substantial recovery and further expansion in the diesel-engine market. The opportunities at home for an engine maker have been severely reduced by the decision of larger users, such as Ford, BMC and Vauxhall Motors, to make their own and to sell them in competition with their former suppliers. The great success of the Ford 4D engine in the industrial field was a major contributing factor to Perkins's inability to get all the turnover they required to fill their highly-mechanised modern factory. New products could not be developed quickly enough to fill the gap.

Steel Framework

The chairman of the United Steel Companies Limited, Mr. W. Benton Jones, devoted a major part of his annual statement to the renationalisation issue. He expressed the strongest views against such a move. Pointing out that all the arguments brought forward by the Labour Party in support of nationalising steel "have been refuted time after time," Mr. Benton Jones suggests that the only reason left to it is the pursuit of an outmoded socialist dogma. "Or perhaps," he writes, "there is even less in it than that," and goes on to tell the (true) story of a little girl who became owner of a double bass and carried it on her back everywhere. "Can you play the double bass?" asked a friend. "Don't be silly," she replied. "Then why do you have a double bass?" said her friend. "Well, you see, it was this way, I told me Momma I wanted one and so me Dadda went and bought me one."

The Steel Company of Wales experienced a slackening of demand in 1957/58. Nonetheless, Mr. Benton Jones is confident that "in the long run demand must continue to increase." He pointed out that, whereas in the USA, the European Coal and Steel Community, and the British Commonwealth, steel production had not quite doubled from 1937 to 1957, that of Russia, China (where an enormous national effort has been made), Japan, and others, had grown from 30½ million to 95 million tons, or by more than three times. The performance of United Steel, and of most other producers, would have been very different had not the motor industry maintained consumption at a high level. Mr. Benton Jones estimates this factor at 2,185,000 tons, or approximately 13 per cent of total steel production in the United Kingdom.

The effect of sales to the motor industry is clearly seen in the results of John Summers, who supply mainly sheet steel to that industry. Their trading profits were up from £9·5 million to £10·04 million (for the year to 30 September), whereas United Steel's, whose sales are very widely spread and not particularly concentrated upon the motor industry, recorded trading profits of £16·7 million, compared to £17·4 million the previous year. Summers' chairman, Mr. Richard Summers, also has his dig at nationalisation. The future he sees untarnished over the next few months: demand for sheet will continue brisk but conditions in export markets are not so favourable.

High Performance

The performance of Ford Motor Company in 1958 is outstanding even by motor-vehicle standards in this year of boom. Output totalled 417,000 units, 17 per cent more than the previous peak of 355,772 reached in 1955. For the first time on record, sales to home and overseas markets each exceeded 200,000. Car and commercial vehicle registrations in the United Kingdom each showed an increase of more than 25 per cent over 1957 and the current figures "continue at an unusually high seasonal level." Abroad, sales in the United States market doubled the 1957 level and accounted for nearly one-fifth of the company's total exports. Overall, Ford accounted for three cars to every ten shipped from Britain last year, and for 38 per cent of shipments to the continent of Europe.

Such a performance is fully in keeping with the company's expectations some three years ago, when they decided on a vast programme of expansion and modernisation, and the timing could not have been better. Two major projects, the Thames foundry and the new body press shop, were commissioned during the year and are now playing a vital part in meeting the increased production schedules. When the new £10 million assembly building goes into operation next spring the programme will be virtually complete and production will presumably climb higher still.

Smiths-Sperry Alliance

There will be much closer collaboration between two of the major suppliers of aircraft control and instrumentation systems, the Smiths and Sperry groups. Smiths Aircraft Instruments and Kelvin and Hughes, both members of the S. Smith and Sons (England) group of companies, and Sperry Gyroscope Company (Brentford Division) are the companies involved. The association is primarily technical. There is to be no financial link-up, nor does the collaboration go beyond specific civil and military aircraft instrument systems at this stage.

In this respect, the joint statement is quite explicit, and also in indicating the main purpose behind the move. "The unique technical resources and facilities of both organisations, specialists in the design of advanced instrumentation and control equipment, are being applied, in the first instance to the development of a flight control and instrumentation system for new British civil aircraft, in particular the de Havilland 121. Proposals are also in hand for similar systems for future military aircraft." The companies involved will retain their separate identities and maintain their existing ranges of products and their present marketing arrangements. An executive panel at director level has been set up to co-ordinate activities under the new scheme.

The new alliance should make possible a speedier development of integrated control systems. The de Havilland 121 project, for example, is likely to incorporate automatic blind landing equipment which is a facility all airlines require for safe and economic operation.

Twelfth in a Series of Consolidated Reports On th

METALLURGY AND FUELS

By
L. M. WYATT, M.A., F.I.M.
Technical Manager, Central Technical Services Research and Development Branch, Industrial Group Headquarters, UKAEA

Canning Materials

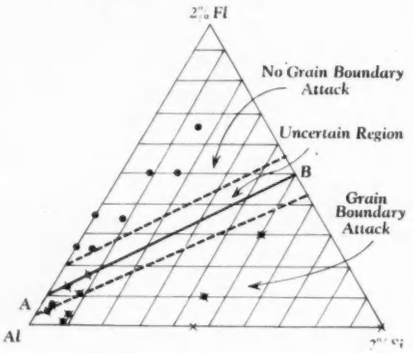
THE second article on metallurgy and fuels is concerned primarily with canning materials, but also includes a consideration of likely trends in fuel-element development. The first article published last week was devoted to fissile and fertile materials.

Aluminium

Its cheapness, low neutron cross-section, corrosion resistance and ductility made aluminium the first choice for reactor cans but it has more recently yielded pride of place to magnesium, zirconium, stainless steel and beryllium. Developments in many countries have been aimed at improving the corrosion resistance of aluminium to high-temperature water so that it can be used in boiling and pressurised water reactors. Some success has been achieved in static water.

Pure aluminium resists water corrosion at low temperatures, but as the temperature is increased grain boundary attack sets in. The addition of iron and silicon inhibits this attack in the region of 200° C, as is evident from Fig. 19 (P767 Norwegian[22]) and the addition of about 1 per cent Ni, 0·5 per cent Fe is protective at higher temperatures.

Fig. 19 (below) Various alloys exposed to distilled water at 200° C. Alloys attacked in the grain boundaries are marked x.



Under dynamic conditions, however, dissolution of the protective Al_2O_3 film occurs. This could, under isothermal conditions, be inhibited by maintaining a high concentration of Al_2O_3 in the water, and phosphoric acid additions are effective (P714 USA[23]). Because, however, the iron and nickel additions can in some circumstances increase corrosion at low temperatures, and the results of corrosion tests are so variable, much more work is needed before aluminium can be recommended in flowing water at temperatures in excess of 175° C.

Magnesium

Second in precedence to aluminium as a canning material, but probably about to surpass it in weight of material canned, is magnesium. The application of magnesium is restricted to gas (carbon dioxide, nitrogen or air) cooled piles fuelled with uranium metal. The design, manufacture and performance of magnesium canned fuel elements have been described in papers from the UK (P50[9]), France (P1157[24] and 1146[25]) and the USSR (P2053[26]). Development in France and England has proceeded on closely parallel lines. Both countries use uranium bars of approximately 1 in diameter for moderate ratings. For higher ratings tubes may be used.

The difficulty of producing a metallurgical bond has led to the employment of mechanical bonding by means of rectangular "antiratchetting grooves" spaced roughly 3 in apart in the British designs, but only ⅛ in apart in the French. End sealing is accomplished in both cases by edge fusion welding of an end "cap" placed in the end of the cartridge, and good contact between can and bar is achieved by gas or hydraulic pressurising at elevated temperatures. Pressures ranging from hundreds to ten thousands of lb per sq. in have been associated with temperatures ranging from 500 to 200° C.

Practice in the two countries has differed in the choice of magnesium alloy and in the heat-transfer surface. Both appear to have considered pure magnesium first, but the British have developed an alloy containing aluminium and small quantities of beryllium, in order to reduce fire risks in the event of an incident in which the carbon dioxide cooling might be replaced by air, while the French have used a 0·6 per cent zirconium alloy which has an inherently smaller grain, is not subject to grain growth at 400° C, and has been shown by them

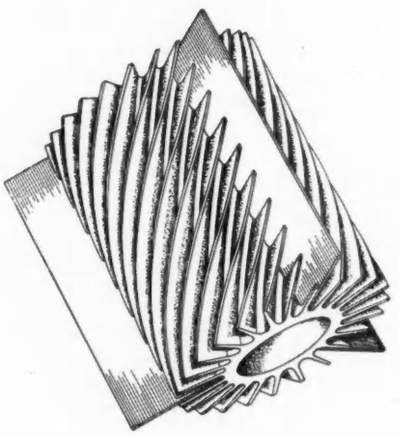


Fig. 20 (above) Polyzonal spiral fuel can.

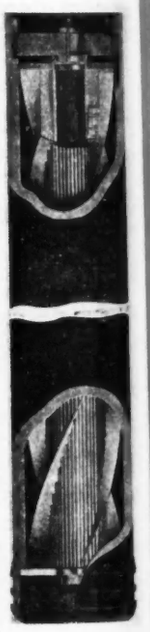


Fig. 21 (right) Part section of Hunterston fuel element.

GENEVA DISTILLATE

Prolific in papers and enormous in scope, the Second International Conference on the Peaceful Uses of Atomic Energy can only assume its true significance when the information presented there has been thoroughly digested. As a stage in this process, ENGINEERING has commissioned sixteen specialists to summarise the matter of the Conference under a number of subject headings. The process may be regarded as one of distillation, with concentrated fractions drawn off at various levels. The contributors have consolidated the information published during the Conference, selecting the essentials, reconciling the submissions of different authors and countries, and tabulating the most important data. As an introduction to the series, we published on 19 September Sir John Cockcroft's overall survey of the Conference. The present series is being published at weekly intervals and will include sixteen articles in accordance with the table. The Conference was held in Geneva from 1 to 13 September.

Power Reactors (28 Nov., page 694) ..	Mr. G. W. K. Ford, Research Manager, Dounreay
Research Reactors (21 Nov., page 662)	Dr. V. S. Crocker, Reactor Division, Harwell
Thermonuclear Research:	
(Pinch Effect) (19 Dec., page 796)	Dr. A. A. Ware, AEI Research Laboratory
(Other Devices) (26 Dec., page 824)	Dr. R. J. Bickerton, Controlled Thermonuclear Research Division, Harwell
Propulsion .. (7 Nov., page 600)	Mr. B. T. Price, Reactor Division, Harwell
Radiation Shielding (31 Oct., page 568)	Mr. J. D. Jones, Reactor Division, Harwell
Reactor Engineering (5 Dec., page 730)	Mr. R. P. Kinsey, Chief Engineer, Advanced Reactor Design Office, Risley
Metallurgy and Fuels (1) (23 Jan., page 106)	Mr. L. M. Wyatt, Technical Manager, Risley
Instrumentation (12 Dec., page 762)	Mr. R. B. Stephens, Mullard Equipment Ltd.
Nuclear Physics (24 Oct. page 536)	Dr. M. J. Poole, Nuclear Physics Division, Harwell Dr. M. Sowerby, Nuclear Physics Division, Harwell
Radioactive Isotopes (14 Nov., page 634)	Mr. E. R. Wiblin, Isotope Division, Harwell
Isotope Separation	Mr. F. I. Hurley, Head of Laboratories, Capenhurst
Chemistry and Processing	Dr. R. Hurst, Director, Dounreay
Radiation Protection	Dr. I. S. Eve, Radiobiological Adviser, Health and Safety Branch
Reactor Safety	Mr. F. R. Farmer, Head of Reactor Safety Division, H & S Branch

On the 1958 Geneva Atomic Energy Conference

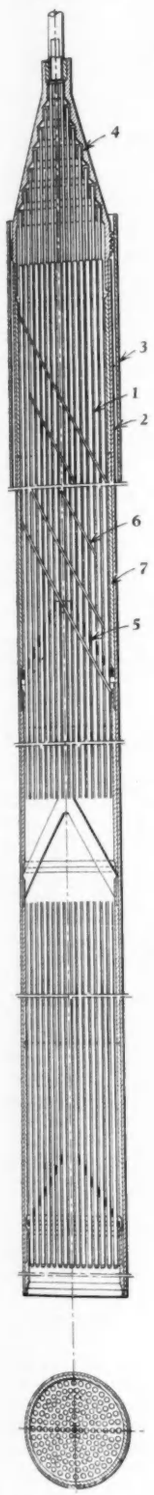
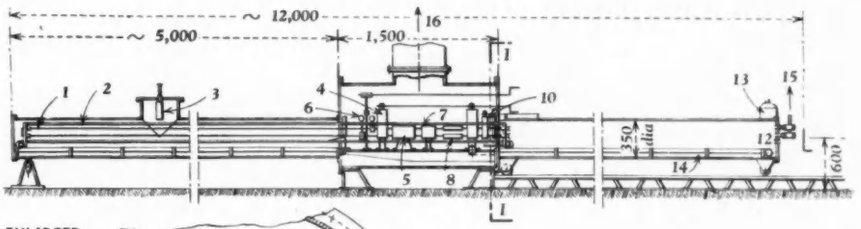


Fig. 22 (left) Natural uranium fuel element for Soviet gas-cooled heavy-water power reactor.

1. Fuel rods
2. Screen tube
3. Aluminium tube
4. Suspension for rods
5. Guiding lattice
6. Spacing winding
7. Protective graphite bush



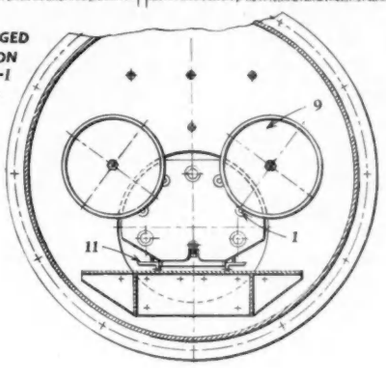


Fig. 23 (right) Installation for canning rods by distillation method.

1. Canning rod
2. Carriage
3. Electric inlet
4. Densifier
5. Rod cooling system
6. Can thickness indicator
7. Beryllium furnace
8. Magnesium furnace
9. System of rod cleansing
10. Electric inlet
11. Rails for carriage
12. Carriage drive
13. Recharging chamber
14. Platform
15. To vacuum pump
16. To diffusion pump
17. Section I-I

to possess superior resistance to fatigue stressing.

Whereas the French have apparently been content to utilise a secondary heat-transfer surface consisting of longitudinal fins on which the elements rest in horizontal channels, great progress has been made both in fin design and support in England. These are best exemplified in the polyzonal spiral fuel element illustrated in Fig. 20 (P48 UK[27]) developed by the Nuclear Power Plant Company for the Bradwell reactor, and the longitudinal finned spiral splitter design invented by the UKAEA and used by GEC in the Hunterston reactors shown in Fig 21 (P1523 UK[28]). The combination of straight and spiral members ensures that the whole of the coolant gas comes into contact with the heat-transfer surface and eliminates free vortices which might lead to excessive pressure drop. The straight splitters on the NPPC design provide excellent support, and ease of withdrawal of the stacked fuel elements, while the spiral splitter in conjunction with the graphite support tube performs the same function for the Hunterston type, which by virtue of its longitudinal fins exhibits great stability of the heat-transfer surface.

The fuel elements for the Russian gas-cooled heavy-water moderated reactor differ fundamentally in design, material and manufacture. Each channel contains at least a hundred 4 mm diameter rods occupying the full channel length, as may be gathered from Fig. 22[26]. Two alloys have been suggested containing respectively 0·5 and 2 per cent of beryllium. The preferred method consists of co-evaporating the magnesium and beryllium on to the uranium cores (Fig. 23[26]) in vacuo. The 2 per cent beryllium-magnesium alloy is deposited in the form of alternate layers which are broken up into a matrix containing acicular particles of $MgBe_{13}$ by annealing. Another method of manufacture consists of preparing the alloy (99·5 per cent Mg, 0·5 per cent Be) by pressure melting and co-extruding the can on to the core. In both cases bonding of the can to the core is said to be achieved through alloying of the beryllium in the alloy with uranium

So far as can be ascertained from the Geneva papers all the magnesium-canned fuel elements behave very well By far the greatest detail on performance and failures has been given by the British. When these are analysed it becomes apparent that less than 0·05 per cent of fuel elements have failed to achieve the desired burnup owing to penetration of the can, and these failures have been due either to the presence of small manufacturing defects in the welds (see Fig. 24[9]) or to the development of leak paths through the can due to straining at low temperatures (see Fig. 25[9]). The tendency to bend reported earlier has been overcome by the use of braces and the excellent appearance of the cans at 1,200 MWD per tonne argues well for their behaviour at higher irradiations.

With the exception of a detailed report on the firing of a magnesium can in an air-cooled pile, little information on performance has been released by France, possibly due to smaller numbers of fuel elements and irradiation levels. It is however likely that the alloy they use will behave better at low temperatures and their limitation of 400° C on can surface temperature suggests easier conditions of operation. The Russians have so far carried out loop tests only. In some of these they have used cold-worked uranium rods. The resulting distortion has subjected the cans to very considerable strain (Fig. 26[26]) but in no case has failure occurred.

The difference between the resistance to strain of this presumably brittle material and the British cans at low temperature is difficult to account for. The good behaviour of the Russian cans may be due to the metallurgical bond between uranium and can. Alternatively it is possible that conditions in the Russian tests have been such that the magnesium is nowhere at a temperature below 350° C, so that penetration is unlikely to occur.

Zirconium

The major use of zirconium is as a canning material for pressurised-water reactors. The parameters governing its use have already been extensively published in America, but there remained some anomalies and discrepancies. One was that Zircaloy 2 prepared in some ways exhibited anisotropy and contained intermetallic stringers, as indicated in Fig. 27 (P1993 USA[29]), which suffered enhanced corrosion and led to premature "breakaway." Similar types of Zircaloy exposed to steam above 450° C suffered an accelerated attack after breakaway, associated

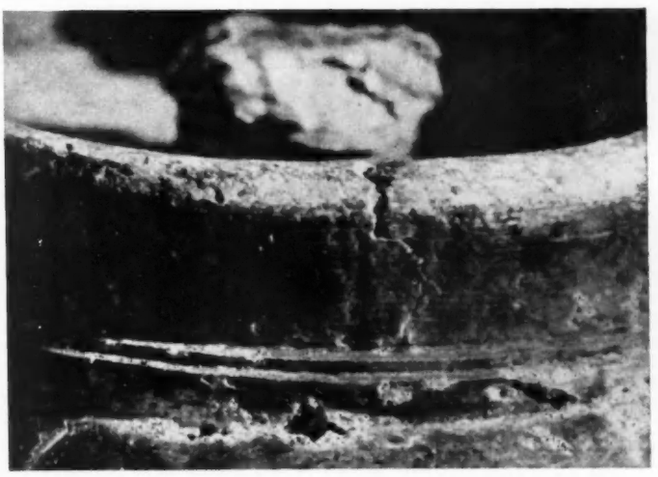


Fig. 24 (above) Transverse crack in end-cap weld.

Fig. 25 (right) Grain-boundary cavities in irradiated Magnox.

Continuing **Metallurgy and Fuels**

with hydriding. Three layers are formed, a centre one of ZrH_3 and two ZrO_2 layers on the surface, and the specimen disintegrates.

Work on the problem at Oak Ridge (see Fig. 28[29]) and Chalk River (P194[30]) have shown that both these phenomena can be overcome by the quenching of material from the beta phase. This process carried out at Chalk River has inhibited hydriding attack (see Fig. 29[30]); a thin oxide film is produced on the surface, and the hydrogen absorption is much reduced. The work at Oak Ridge has led to the following sequence of operations in the production of Zircaloy sheet: (1) forge between 970 and 1,050° C; (2) roll to within 125 per cent of final thickness between 500 and 785° C; (3) beta heat treat and quench; (4) roll to finish gauge between 480 and 550; and (5) alpha anneal and quench. Zircaloy plate manufactured in this way has the microstructure shown in Fig. 28[29].

Fig. 27 (below) Microstructure of a Zircaloy-2 plate fabricated using conventional commercial practice.

Note preferred orientation and large intermetallic stringers.

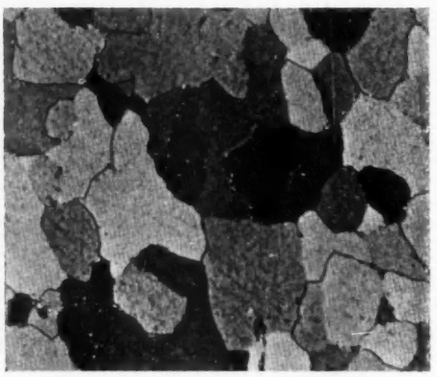


Fig. 28 (below) Microstructure of a Zircaloy-2 plate fabricated using new procedure.

Note reduced preferred orientation, absence of intermetallic stringers, but presence of small gas stringers.

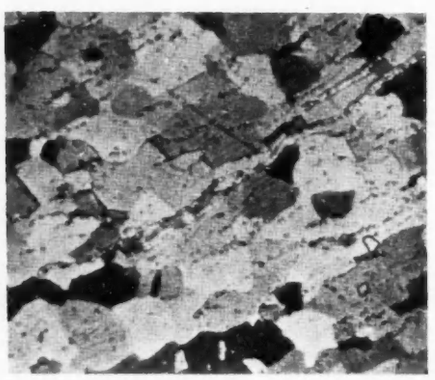
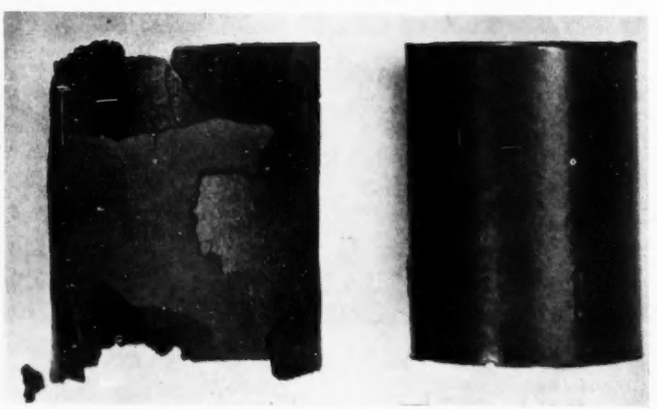


Fig. 29 (below) Comparison between α-annealed (left) and β-heat-treated Zircaloy-2 tubing after 24 hours in steam at 540° C and 100 atmospheres.



The zirconium alloys commercially available are satisfactory for service in pressurised and boiling water reactors up to temperatures in the region of 300° C. The economics of these reactors would be much improved if this temperature could be sufficiently increased. Continuous research is in progress in America and Russia in an attempt to improve these alloys, and the favourite alloying addition is niobium. There are indications for example that the 15 per cent Nb-Zr alloy is more resistant to corrosion from uranyl sulphate solutions under irradiation than the Zircaloys. Other alloying additions are required to overcome brittleness in this case.

In Russia very extensive investigations have led to the "Ozhennite" series of alloys. These alloys are basically of the Zircaloy type with the chromium replaced by niobium. Ozhennite 0·5 has the composition Sn 0·2 per cent, Fe 0·1 per cent, Ni 0·1 per cent, Nb 0·1 per cent. These alloys have been shown to have excellent corrosion resisting properties, as is evident from Fig. 30 (P2044 USSR[31]), although comparison with the Zircaloys is made difficult because the Ozhennites have all been made from highly pure iodide process zirconium. The Russians also find good corrosion resistance properties in binary zirconium, niobium and tantalum alloys, but the latter of course have inferior nuclear properties. An accurate comparison of Ozhennites and Zircaloys under controlled conditions would be of considerable value because so much of the value of steam as a coolant depends on finding a good corrosion resistant structural material of low neutron cross section.

Probably the most important unknown affecting the performance of zirconium alloys in steam and pressurised water is the extent to which embrittlement by hydrogen, either picked up during corrosion or absorbed directly from the gas, will limit life or operating temperature. This phenomenon, which is of particular importance where pressure tubes are used to contain an aqueous coolant, is complicated by the tendency of hydrogen dissolved in zirconium to diffuse to the coldest point. This diffusion has been studied quantitatively (P709 USA[32]) and the behaviour of hydrogen dissolved in zirconium in a steady-state temperature gradient can be predicted.

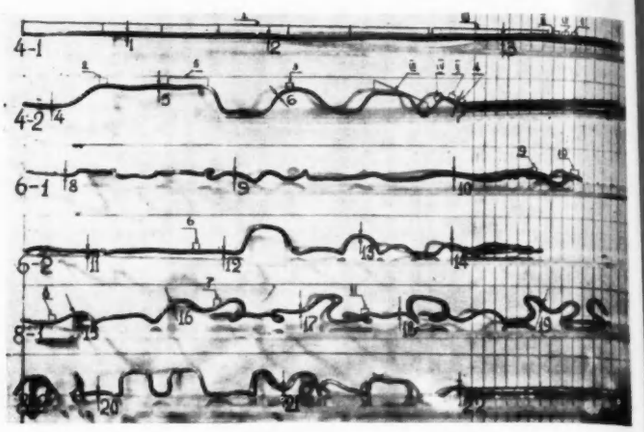


Fig. 26 Non-heat-treated fuel rods after irradiation in a reactor.

Hydrogen in zirconium is not, however, always a disadvantage. Alloys of Zr:U:H of atomic ratio approximately 1:0·03:1 are now being produced by the addition of hydrogen to conventionally produced zirconium-uranium alloys (P789 USA[33]). This material combines fuel diluent and moderator in one, and cooled with NaK has been found very satisfactory for use in low-power reactors. Care is required during manufacture to overcome cracking and warping, but ½ in diameter, 14 in long specimens have been produced with bow not exceeding 0·050 in. The material has the following properties: Young's modulus 14×10^6 lb per sq. in; ultimate tensile strength 14 tons per sq. in; specific gravity $p = 6{\cdot}83 - 0{\cdot}55v$ where v is the H:Zr ratio. Resistance to boiling distilled water is good and no deterioration results from irradiation to a burnup of 2·5 per cent of the uranium. The thermal conductivity is shown in Fig. 31[33].

Zirconium also has applications as a structural (and perhaps a canning) material in carbon-dioxide cooled reactors. Its corrosion resistance in hot carbon dioxide has been studied (P1450 UK[34]), and improvements have been achieved by alloying with molybdenum, tungsten and copper up to 1·5 per cent. Ternary additions do not present any advantage corrosion-wise over the binary alloys, but may have beneficial effects on the creep properties. The most promising alloy so far investigated contains 1·0 per cent Cu, 1·5 per cent Mo. Outstanding improvements are not, however, expected and the use of zirconium in carbon dioxide cooled reactors at temperatures in excess of 500° C cannot at present be visualised.

Steel

In addition to their importance as structural materials, in particular in pressure vessels, steels are taking a more important role as canning materials and diluents for fissile material.

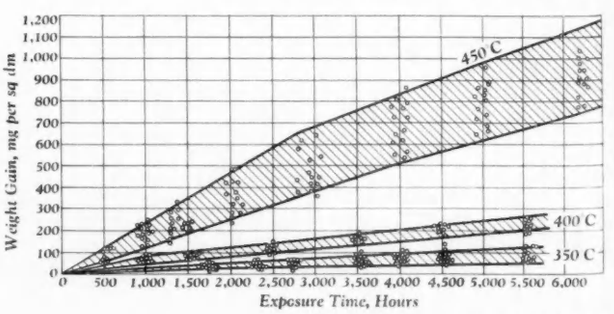


Fig. 30 (above) Corrosion of zirconium alloys in the Ozhennite range in water and superheated steam at various temperatures.

(*a*) Ozhennite 0·5—0·2 per cent tin, 0·1 per cent iron, 0·1 per cent niobium, 0·1 per cent nickel.
(*b*) Ozhennite 1·0—1·0 per cent tin, iron, niobium and nickel; at 350 to 400° C the corrosion resistance of the alloy varies insignificantly. At 450° C the upper points belong chiefly to the Ozhennite 1 alloy, and lower points to the Ozhennite 0·5 alloy.

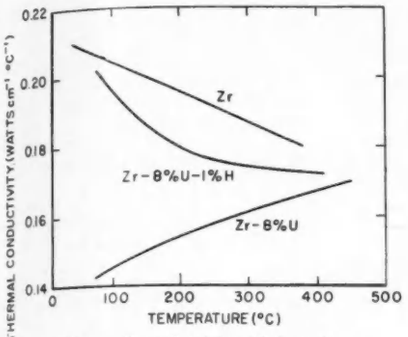


Fig. 31 Thermal conductivity of zirconium-uranium-hydrogen alloys.

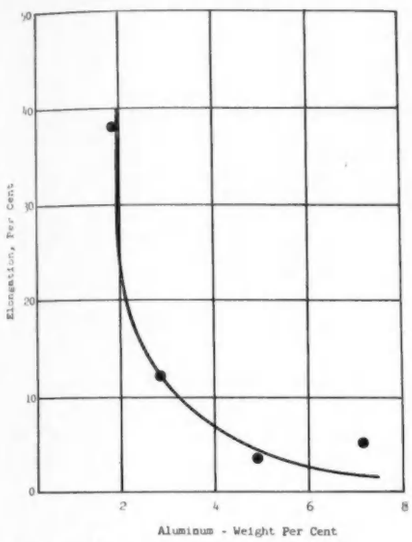


Fig. 32 Effect of aluminium on ductility.

This they are able to do because of their excellent resistance to attack (they can be used with bismuth, sodium, water and most gases), because their consistency of performance and long established technology enable increased refinement in design, and because of their low cost which is becoming even more important, as the cost of fissile material tends to decrease. The canning material in general use is austenitic stainless steel. The 18/8/1 type is, of course unstable and suffers from increase of strength and loss of ductility properties under irradiation. These effects can be much reduced by using fully austenitic materials.

Any possible method of reducing neutron absorption would be of great benefit and it has been suggested that iron alloys of the " Kanthal " type containing up to 10 per cent aluminium might be used. These alloys possess excellent oxidation resistance and volume for volume should have only about 65 to 75 per cent of the neutron capture cross-section of the austenitic stainless steels.

A systematic development programme is under way with the object of overcoming the lack of ductility (see Fig. 32 taken from P707 USA[35]), which is the chief disadvantage of these materials and considerable success has been achieved by the addition of 5 per cent Cr 1 per cent Nb, ½ per cent Ti to the 7½ per cent aluminium alloy. If really ductile alloys can be developed these alloys, which are made from intrinsically cheap constituents, will assume a very important role as canning materials.

Beryllium

From the earliest days of nuclear energy, the potential advantages of beryllium, its hot strength and low neutron absorption cross-section have been recognised. So far however its general application has been held back by its disadvantages. It is costly, both on account of its scarcity and of the difficulties attending its extraction; and its fabrication in a ductile form is made hazardous by its toxicity which complicates handling. There are very few reactor materials with which it is compatible at operating temperatures. It alloys with all metals except tungsten, molybdenum and possibly chromium at temperatures above 600° C and with iron at temperatures above 500° C. Thus for long-term use in most coolants, contact must be restricted to graphite, or highly stable ceramics such as beryllia or UO_2.

Perhaps the most difficult problem to assess with beryllium is the extent to which the production of helium by fast neutrons, amounting to 2·6 cu.cm of gas at NTP per cu.cm of beryllium in an integrated reactor flux of 10^{21} neutrons per sq. cm will affect reactor performance. Embrittlement occurs at low temperatures and swelling has been observed above 700° C.

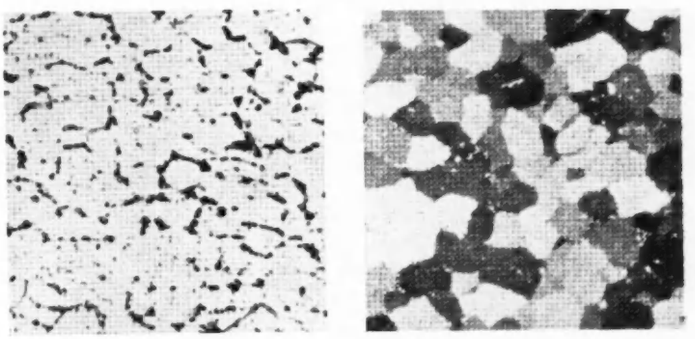
These problems can be overcome with careful design; the good irradiation stability of UO_2 should reduce the stresses imposed on beryllium to an acceptable value throughout the life of a fuel element, and new extraction and fabrication techniques should both reduce cost, and provide desirable properties where they are required in components. Beryllium has operated satisfactorily both in short-germ irradiation tests on prototype fuel elements and also in the moderator of the reactor in the submarine Seawolf. Its use in the British Advanced Gas Cooled Reactor will lead to an increase in outlet temperature to 500° C (P312 UK[36]).

Fuel Element Trends

When the bewildering array of fuel-element types have been analysed certain trends become

Fig. 35 (below) Microstructure of a gas-pressure bond between Zircaloy-2 plates.

The bond line, which is indistinguishable, is in the centre of the field, running horizontally. No contamination is evident in the left-hand view (bright-field illumination) and no lack of grain growth in the right-hand view (polarised-light illumination).



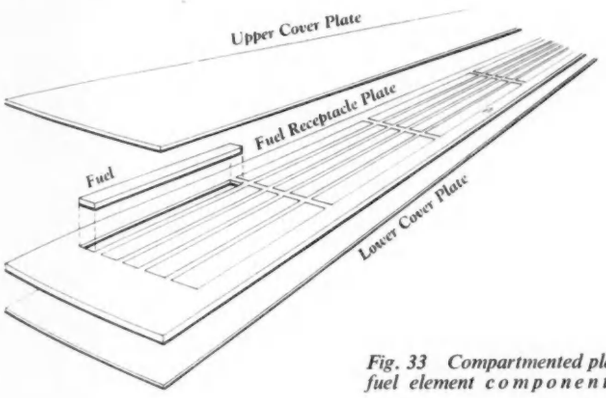
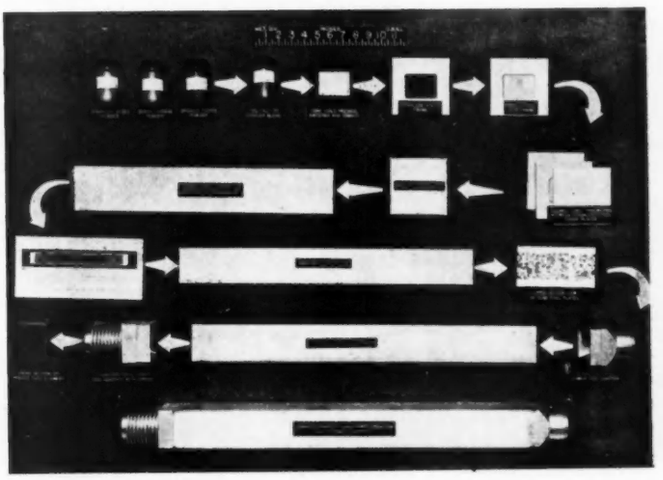


Fig. 33 Compartmented plate fuel element components.

Fig. 36 (below) Fabrication procedure for making APPR fuel components.



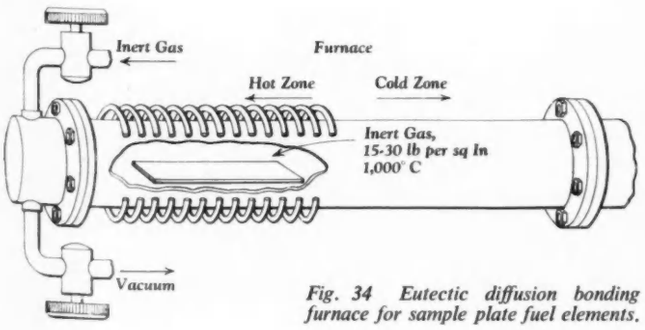


Fig. 34 Eutectic diffusion bonding furnace for sample plate fuel elements.

Continuing **Metallurgy and Fuels**

apparent. The most important of these are as follow.

1. There is a significant and praiseworthy attempt to cheapen fuel elements by simplification in design and production methods.
2. A trend in thermal reactors away from uranium metal towards uranium oxide on account of its dimensional stability over a wide range of temperatures is taking place.
3. Increased use is being made of the dispersed or " diluted " type fuel element.
4. A marked increase is apparent in the use of " integral " methods of canning instead of the earlier techniques of placing an already manufactured uranium bar in a preformed can, followed by welding.

The tendency to cheapen and simplify is shown in many ways. The magnesium cans for the United Kingdom's gas-cooled reactors which were made by machining from the solid for the original Calder Hall reactors will in future be made by metal-working methods. In the case of the larger industrial reactors this has been facilitated by the design of finning which allows for manufacture by extrusion followed in some cases by twisting.

Determined attempts are also being made to cheapen the canning process for the Shippingport pressurised-water reactor. The blanket fuel elements of the first charge consisted of assemblies of rods and the production of the UO_2 to the necessary accuracy, and the welding of the tube assemblies has proved very expensive. Use was therefore made of the " gas pressure diffusion bonding process " described independently in two papers (P788[37] and P2380[38] USA) to manufacture plate-type elements which will have higher thermal performance, increased life and cost less. The fuel element design is shown in Fig. 33[38]; and for the PWR the surfaces to be joined are first plated with nickel, copper or iron after which the edges are seal welded and the whole assembly heated under pressure in an autoclave (see Fig. 34[38]).

Westinghouse have apparently only considered this process for the blanket elements, but Battelle and other investigators not only weld zirconium perfectly without use of an intermediate metal (Fig. 35[37]) after abrading the surface with silicon carbide grit in oil, but suggest that seed type fuel elements can also be made cheaply by this method.

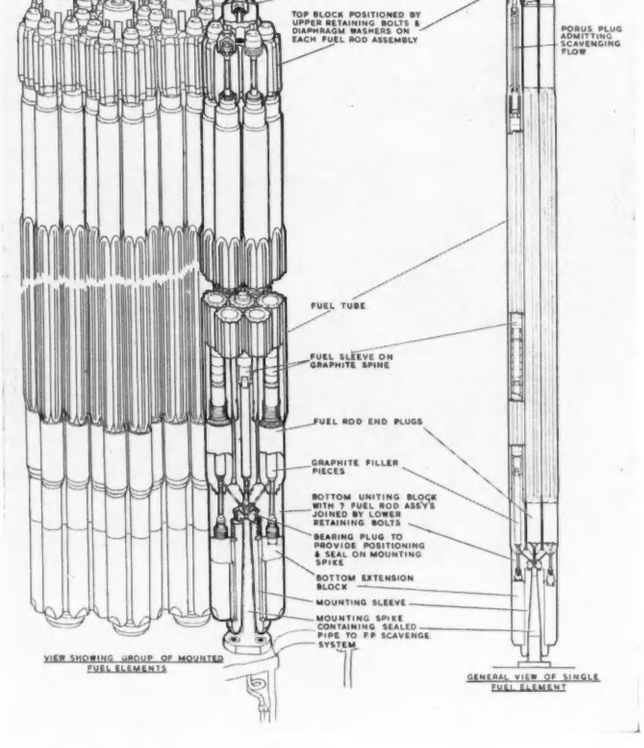

LIFTING EXTENSION IN TOP BLOCK
TOP BLOCK POSITIONED BY UPPER RETAINING BOLTS & DIAPHRAGM WASHERS ON EACH FUEL ROD ASSEMBLY
POROUS PLUG ADMITTING SCAVENGING FLOW
FUEL TUBE
FUEL SLEEVE ON GRAPHITE SPINE
FUEL ROD END PLUGS
GRAPHITE FILLER PIECES
BOTTOM UNITING BLOCK WITH 7 FUEL ROD ASSYS JOINED BY LOWER RETAINING BOLTS
BEARING PLUG TO PROVIDE POSITIONING & SEAL ON MOUNTING SPIKE
BOTTOM EXTENSION BLOCK
MOUNTING SLEEVE
MOUNTING SPIKE CONTAINING SEALED PIPE TO F.P. SCAVENGE SYSTEM
VIEW SHOWING GROUP OF MOUNTED FUEL ELEMENTS
GENERAL VIEW OF SINGLE FUEL ELEMENT

Fig. 38 (left) Fuel elements for high-temperature gas-cooled reactor experiment.

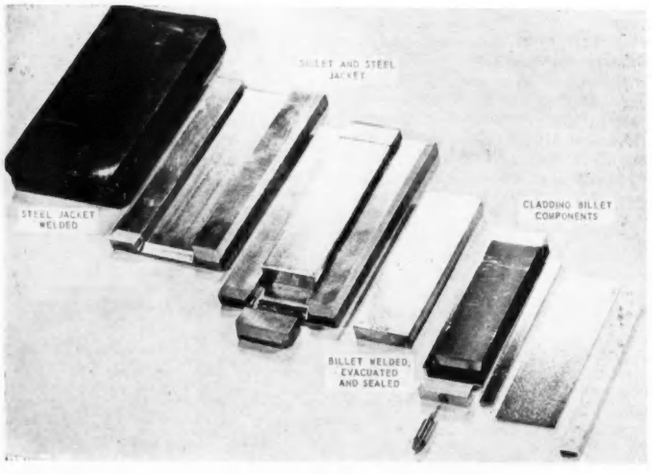


Fig. 39 (lower left) Cladding billets for the Experimental Boiling Water Reactor at various stages of preparation.

Fig. 40 (lower right) Fuel rods for Experimental Breeder Reactor No. 1 in various stages of manufacture.

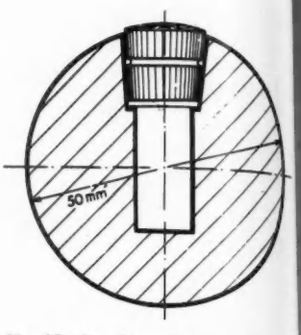
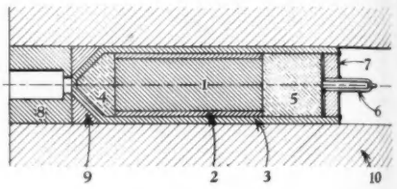


Fig. 37 Graphite sphere as used in fuel element for high-temperature reactor.

Further examples of the trend to cheapen fuel-element manufacture are the Canadian experiments on swaging UO_2, and the American production of 3,300 lb " Dingots " of uranium, though whether this process actually works out cheaper than that of direct casting as favoured in England is doubtful. It would in fact appear that the British technique of fluidised bed processing followed by casting should be both the

Fig. 41 Billet assembly for Enrico Fermi power reactor (see table below illustration).



No.	Description	Material	Size
1	Billet	U-10 w/o Mo	0·867 $^{+0·001}_{-0·000}$ dia., 2·312 ±0·003 in long
2	Billet sleeve (cladding)	Zirconium	0·916 $^{+0·000}_{-0·002}$ o.d., 0·869 $^{+0·001}_{-0·000}$ i.d.
3	Oxidised can, spun nose	Mild steel	1 $\frac{1}{16}$ in o.d. by 0·065 in wall
4	Nose plug	Cu-17 w/o Ni	0·920 in dia. for $\frac{1}{2}$ in length, 45° taper to $\frac{1}{4}$ in dia. flat
5	Cut-off plug	Cu-17 w/o Ni	0·920 in dia. by 1 in long
6	Evacuation tube	Mild steel	$\frac{1}{4}$ in o.d. by $\frac{1}{16}$ in wall
7	End plug	Mild steel	0·920 in dia. by $\frac{1}{4}$ in thick
8	Die	18-4-1 Hi-Speed steel, 45-50 Rockwell C	1 $\frac{1}{16}$ in o.d., 0·250 in i.d. over $\frac{1}{4}$ in land, 1 in long
9	Cone	Type 304 SS	1 $\frac{1}{16}$ in dia., 90° included angle, $\frac{1}{8}$ in dia. opening
10	Extrusion liner	Steel	1·100 in i.d. by 11 in long

most elegant and the cheapest route between concentrate and fuel element yet proposed.

The trend towards UO_2 is self explanatory. It is likely that sodium-cooled reactors, where high rating is a major advantage, and fast reactors, where alloying does not impose serious neutron penalties, will continue to use metal fuel, and some development is required before the economies of the Magnox canned reactors is bettered: but the advantages of long burnup, higher temperature, improved compatibility with coolant, and ease of addition of plutonium must in the end prove decisive. Three important groups of reactors, the AGR of the UKAEA, and the Shippingport PWR and the Vallecitos BWR of the United States all use oxide fuel.

The reason for the trend towards diluted fuels is also clear. These are essential where pure fissile material is burnt, as only in this way can the necessary high ratings be obtained. The uranium aluminium and uranium zirconium alloys, uranium dioxide aluminium cermets have long been known.

Another important development is the use of uranium dioxide stainless-steel cermets in the Army Package Power Reactor (P1925 USA[39]). These are made in a conventional manner by powder compacting, cold rolling and brazing (see Fig. 36[39]) and withstand irradiations up to 3 per cent of total core atoms at temperatures up to 800° C. The only effects observed are a hardening of the core which is at a maximum at 400° C, and is reduced by roughly half by increasing particle size of the UO_2 from 7 to 100μ in diameter.

Future developments of diluted fuels may include the dispersions of uranium 235—thorium fuels in graphite canned in graphite. Two types of fuel element are proposed, a pebble-bed type (P1005 German[40]) as shown in Fig. 37, and a rod bundle fuel element (P314 UK[41]) illustrated in Fig. 38. Great progress has been made in the production of strong and impervious graphite for the fuel elements of both these reactors. For future versions it may be possible to use beryllia instead of graphite, which will give improved neutron economy and smaller size. Irradiation tests so far carried out on beryllia show no effect on any of the properties except the thermal conductivity.

The number of fuel elements made by integral canning methods increases. To the research reactors and prime movers is now added the Experimental Boiling Water Reactor (EBWR), of which the first charge consists of low-alloyed uranium-metal fuel elements roll clad with Zircaloy 2 (see Fig. 39, taken from P790 USA[42]). The good behaviour of these fuel elements speaks well for the integrity of the cladding since the core is rapidly attacked by water. The EBR-1 Mk. III fuel elements use extrusion clad rod, to which ends are resistance welded (see Fig. 40, taken from P791 USA[43]), and extrusion cladding is used for the Enrico Fermi power reactor, as may be seen in Fig. 41 (P792 USA[44]). Uranium metal fuel elements clad with beryllium which performed well at low irradiations have also been made by co-extrusion and integral forging (P319 UK[45]).

Even when the difference in properties of fuel and can make co-working impossible, success has been achieved in extruding the can over a preformed bar. The initial troubles experienced in manufacturing cans for the NRX were overcome in this way, and the Russians have used the technique in applying the cans for their gas-cooled heavy-water reactor.

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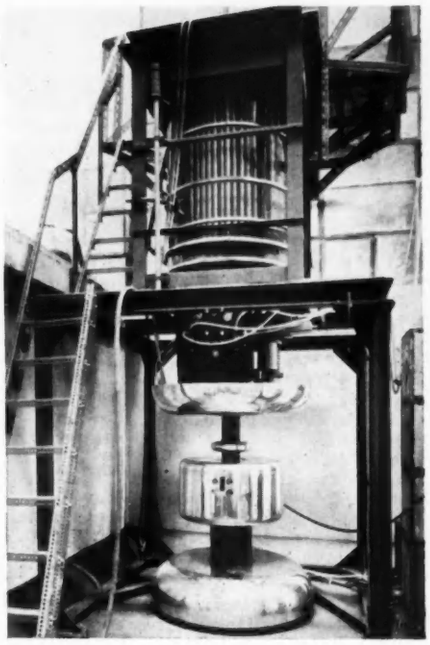
Atomic Review

For Teaching Purposes

AIDS to nuclear education. Notes and News.

Sub-Critical Facility

Miles Hivolt are now marketing a light-water moderated sub-critical reactor together with ancillary equipment to make up a complete sub-critical facility laboratory. The plant is shown in the accompanying illustration. The basic elements of this laboratory will be a pulsed neutron generator, a water-moderated sub-critical reactor operated either from a radioactive source or the pulsed neutron generator, together with all the necessary instrumentation. The installation is designed for reactor research, development and design, and advanced education in nuclear engineering. The pulsed neutron



generator can be detached from the reactor to permit studies on materials and on physical problems in reactor construction.

Teaching Nuclear Engineering

"Many of the problems of nuclear engineering," states Dr. P. H. Price in the *Bulletin of Mechanical Engineering Education*, "consist of conventional operations performed under conditions of irradiation which require novel engineering materials, or the remote control of a shielded or sealed process." No new principles are involved in such problems so that in a course on fundamentals they can be neglected. Techniques peculiar to nuclear engineering, however, which may be demonstrated on a moderate budget are listed as follow: neutron moderation, neutron diffusion, neutron production on fission, nuclear reactor kinetics and absorption of gamma radiation. Instruments required are ionisation chambers, proportional counters and Geiger-Müller counters, and initially experiments might be carried out to determine their characteristics. Useful experiments which may have to be excluded on grounds of cost are concerned with neutron shielding, more ambitious neutron cross-section work and exponential experiments. In the article, "Some Demonstration Experiments in Nuclear Engineering," Dr. Price outlines a number of demonstrations which, with the exception of those requiring a graphite stack, can be performed without major expenditure. The article appears in the January, 1959, issue of the *Bulletin*, which is published by the Manchester College of Science and Technology.

Home Study Course in Nuclear Engineering

The outline curriculum of a home-study course in nuclear engineering is provided in an illustrated introductory guide issued by CREI Atomics, a division of the Capitol Radio Engineering Institute, 3224 Sixteenth Street, N.W. Washington 10, D.C.

HTGC Experiment to Begin Operation

It is reported that tests are to begin next month on the high-temperature gas-cooled reactor experiment at the UKAEA's establishment at Winfrith Heath.

Full-Time Member of UKAEA

Sir Alan Hitchman, Permanent Secretary, Ministry of Agriculture, Fisheries and Food, is to succeed Mr. W. Strath as a full-time member of the UKAEA on 1 April. Mr. Strath is to become Permanent Secretary, Ministry of Supply.

The Human Element

Original Research at School

The Committee on Scientific Research in Schools was established in March, 1957, by the Royal Society " in order to assist school masters and mistresses who wish to pursue research work in science." Their first report, covering sixteen months of their existence, during which they met four times, was published last week. The committee was originally constituted of six members: three, including the chairman, Sir Linder Brown, acting for the Royal Society, and three for the Science Masters' Association. Dr. C. G. Williams, director and general manager of Shell Research Limited, was appointed an additional member in July, 1957. The committee are warmly appreciative of the part played by Shell Research, stating that they had been " greatly encouraged and assisted by the public spirited attitude of this company which, in 1956, took up this question and is at the present time supporting research work in nine schools."

A statement about the establishment of the committee and their aims was circulated to the heads of 1,383 schools in the British Isles in November and December, 1957. Requests for advice have been received from 57 school masters and school mistresses, and twelve research projects are at present being undertaken with the assistance of the committee, in addition to those previously initiated by Shell Research Limited. Twenty-one additional research projects are at present under consideration. Very valuable help has been arranged for participants: the Science Museum have agreed to consider lending periodicals to those persons carrying out work under the advice of the committee, " considerable assistance over making literature available " has been given by the various university departments and the Royal Institution library may be used for a small subscription. In addition, all research projects with which the committee is dealing have been scrutinised by Fellows of the Royal Society or by others, and these have most generously agreed to act as advisers. In a number of instances, Fellows have lent apparatus from their own departments for particular projects. In the opinion of the committee an adviser for each project is most desirable.

Back to Cambridge

When Sir John Cockcroft was asked why he had decided to accept the invitation to be the first Master of Churchill College, he replied without hesitation " I have always felt that I would like to return to Cambridge sometime. After all, I have lived and worked there for 17 years." But he added that he hoped he would be able to continue some connection with the Atomic Energy Authority.

The date of Sir John's return to Cambridge is not yet fixed. He is already one of the trustees of the College Trust Fund, and he is one of the selection committee who will shortly be examining the competition entries from architects for the design of the College buildings. Mr. Basil Spence, the architect of the new Coventry Cathedral, is another of the selection committee. The first big residential block is expected to be ready by October, 1961, but the first undergraduates will be entering before then. So it looks as if Sir John's work for the College will gradually build up until the day when he officially becomes Master.

Lord Weeks, one of the trustees, said that they attached great importance to the Cambridge principle that students of widely differing subjects should be associated in every college. But they had to consider two factors which would arise in the near future: the " bulge " arising from the high birth rate immediately after the war, the effect of which will be felt in the universities in the early 1960's; and the rising proportion of school children electing to stay on at school and enter the sixth form, and subsequently enter a university. And as there is an increasing shift in sixth forms from arts to science, Churchill College will admit seven students of the natural and applied sciences and mathematics to every three arts students. This proportion will apply to the 360 undergraduates and 180 postgraduate students for whom accommodation is to be provided. The appointment of Sir John Cockcroft as the first Master seems to be in line with this decision. Future Masters are to be appointed by the Crown.

Early Distinction

The Royal Society of Arts have awarded the third Benjamin Franklin medal to Mr. Henry George Nelson, managing director of the English Electric Company " for his work in scientific industrial development." The award, which was approved by H.R.H. The Duke of Edinburgh, President of the Society, is made annually " to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufacture and commerce."

Mr. Nelson's rise in industrial eminence has been remarkable, for he is only 42 and has been managing director since 1956. The fact that this has been achieved in the formidable shadow of his father, Sir George Nelson, the company's chairman, further enhances its merits, for few sons can match illustrious fathers as Mr. Nelson has done. He was educated at Oundle and King's College, Cambridge, and obtained his engineering training in England, France and Switzerland. He joined English Electric in 1939, as superintendent of their Preston Works. In 1942 he was appointed managing director of D. Napier and Son, and in 1949 deputy managing director of the parent company, succeeding his father as managing director seven years later.

The first two Benjamin Franklin medals were awarded to Professor F. C. Williams, F.R.S., in 1957, and to Mr. Peter Ustinov last year.

Chest Check

A scheme for a regular X-ray check of those who work in the mines has been introduced by the National Coal Board. This has been approved by all unions in the industry. The examination of mineworkers will be voluntary, and all results are confidential between the individual and the medical service. Special vehicles, which have been built to the design of the medical service, will visit every colliery at regular intervals. These house " the most modern and efficient X-ray equipment for taking full-size X-rays."

This is a major step forward in the NCB's campaign to promote the health and safety of their workers. So far their efforts have been concentrated on the prevention and suppression of the dust which occurs when coal is mined. It will be interesting to see how far this has successfully diminished the incidence and arrested the spread of lung disease. The next step will be to provide sanatoria for treatment and convalescence.

Through a Film Clearly

A new series of film strips dealing with the history and basic principles of important scientific achievements has been announced by the Mullard Educational Service. These are aimed primarily at secondary modern pupils but the company hope that they will also be useful " for grounding grammar school arts pupils in some science subjects."

The first film strip available is entitled " The History of Radio," and it reviews the progress made in telecommunications from the days of the first primitive telegraph and telephone systems. Wherever it is necessary to the development of the story, fundamental principles of electricity and magnetism are simply and concisely explained. The distributors are Unicorn Head Visual Aids Limited, who supply a set of teaching notes with the strip. The next filmstrip, " The History of Television " will shortly be available.

Dividend in Place of Bonus

Civil engineering probably has more mobility of senior technical staff than other branches of engineering or industry. In these days of scarce technical resources, there is every incentive for concerns to keep their top men, and those who soon will be the top men. This applies with particular force, therefore, to civil engineering.

It is of interest that Richard Costain Limited have come forward with a share purchasing scheme. Under this plan, salaried staff will be able to borrow an amount varying with their salary to buy the company's shares at a price between 90 and 100 per cent of their market value. Generally speaking, the first 30 per cent of the loan will be repaid from dividends and thereafter a rate of interest will be charged. This scheme is instead of any form of bonus payment. The company hope it will encourage saving and create an incentive for middle management to stay with the group.

Existing shareholders have been consulted although there is no legal obligation to do so. Several large shareholders have signified their consent. Existing directors are specifically excluded from the scheme though future directors from within will eventually come forward as shareholders. Lloyds Bank Limited have agreed to act as trustees and will manage the scheme.

Aboriginal Sin ?

The discussion last week by the Australian Citizenship Convention of Sir Macfarlane Burnet's paper on migration is a landmark in Australian thinking on racial questions. At the close of the convention the author of the paper said that the handling of the problem of mixed marriages might improve relations with Asian countries.

Probably only a small number of people in Australia are prepared to view objectively the question of mixed marriages, whether it be put in terms of strengthening the racial stock (and slightly darkening its colour) or of Pacific area politics. Some believe that the sustained power of the early Egyptian kingdoms arose from the continual invigorating influx of alien races; such as the Hyksos, the nomadic tribes who were invariably assimilated without changing the fundamental character of the nation. Others may suspect that the consequences were delayed action.

Australia has for long enough seen itself as a white area in an oriental setting and has been quite prepared to live with the consequences of looking what it is, namely, a large unpopulated area near to large over-populated ones. In sociological terms, its position is basically provocative to other races outside the continent and it is therefore a source of political instability —an outstanding case of plenty in the midst of poverty and hence a temptation to the strong. No one in the Pacific has yet been quite strong enough to do much about it though the Japanese got very close to it. Strength has been with the white races. This may not always be so now that China is stirring and it will do only good for the Australians to think carefully about this exceedingly difficult problem with a high emotional content.

Automobile Engineering

FREIGHT ACROSS FRONTIERS

As a sort of international new-year gift several European countries have granted additional customs facilities to motorists. These were agreed at a session of the Economic Commission for Europe's inland transport committee in Geneva. Norway no longer requires customs documents for private cars, and Italy has brought in a simplified pass called a *tessera*. France is still considering the whole question of control.

In several cases facilities have been granted to hired cars without special documents. The three Scandinavian countries and Austria and Switzerland, accept hired cars either with driver or drive-yourself on the same terms as private cars. The same facilities are also being extended to hired drive-yourself cars in the Benelux countries and West Germany. For commercial goods vehicles, Norway and Sweden require no customs documents. Austria, Denmark and Switzerland propose to waive the requirement but have not decided from what date. Germany is dispensing with customs documents for goods vehicles from 1 January. France, Italy and the Benelux three are still considering the matter.

Where documents are still required a standard triptych will be introduced on 1 May this year. Another decision affecting goods vehicles was the adoption of a new text supplementing and simplifying the TIR (International Road Transport) Convention covering the carriage of goods across frontiers in sealed containers. Other matters considered by the experts were the conditions covering the temporary import by rail of road trailers and the customs regime applicable to pallets. A system of granting duty-free admission was agreed for pallets pooled by railway authorities, or road hauliers. In case anyone should think that the committee concerned itself only with broad principles it is worth noting that it was agreed that the covers of lorries could be secured by plastics cord.

VOLKSWAGEN PROVING GROUND

A 60 acre proving ground in Wolfsburg has been constructed to keep a check on the quality and safety of Volkswagen models. It reproduces road surfaces and driving conditions met by drivers all over the world. A 1·12 mile oval concrete test track runs round the proving ground with banked curves on which speeds of 93 m.p.h. can be obtained without side thrust. There is a steering pad and 33 ft high test hills with four different gradients. There are strips of bumpy noisy asphalt, a cobblestone track with pot-holes and cracks, and a concrete corrugated track. The 2,500 Volkswagens produced every day are tested on this proving ground, eliminating the risks of testing on public highways.

HEATER AND DEMISTER

Designed primarily for use in the cabs of commercial motor vehicles is a combined heating and demisting unit now being made by Clayton Dewandre Company Limited, Titanic Works, Lincoln. The D9 unit measures 8½ in by 7⅝ in by 7½ in and has four removable outlet panels so that the arrangement best suited for any particular cab can be obtained. Up to six demister nozzles can be fitted to the panels to feed selected points. Heat is supplied from the engine cooling water system and the unit has an output of 9,000 Btu per hour (approximately 2½ kW) when the cooling water is 120° F above the ambient temperature. Air flow is 105 cu. ft per minute.

In Parliament

RAILWAYS INTO ROADS

Meetings of the two Houses of Parliament were resumed on 20 January after their adjournment on 18 December for the Christmas recess. One of the earliest matters to be brought to the attention of the House of Lords was an inquiry by Earl Howe (Conservative) as to what consideration was being given by the Government to the question of transforming into roads the many branch railway lines that have been closed down in various parts of the country. In particular, he wondered whether the initiative in dealing with specific cases came from the Ministry of Transport and Civil Aviation or from the local road authorities.

Replying for the Government, the Earl of Gosford, a Lord in Waiting, said that when a railway line to be closed permanently was near a proposed new road, the possibility of using it in the construction of the road was considered by the highway authority concerned, which must be satisfied that such a course was justified on both engineering and economic grounds. An example of such a conversion was the Heads of the Valleys road-improvement scheme now in being, which used part of the Abergavenny-Methyr line.

Local authorities were responsible for providing roads. They informed the Ministry of any roads which they proposed to build in their district, and, at the same time, the Ministry informed them of any railways anywhere near that area which were to be, so to speak, derequisitioned.

NEW PUBLIC WORKS

In the Commons, it was suggested to the Prime Minister by Mr. Stephen Swingler (Labour) that, in view of the human and economic consequences of unemployment, the Government departments concerned with the building of houses, roads and schools could immediately increase their programmes in areas of high unemployment.

Mr. Arthur Woodburn (Labour) felt that the extension of public works was not a general problem, but that there were very definite black spots of unemployment in the country, whereas other parts were quite prosperous. He urged the Prime Minister to ask all departments to look into the possibility of lowering the pressure just a little in the prosperous areas and of diverting some of the orders into other areas which had heavy unemployment, such as Scotland.

The Government, Mr. Harold Macmillan replied, has taken positive measures to deal with unemployment generally and areas of high unemployment in particular. As had been announced on 3 November, large increases had been authorised in expenditure in the public sector of industry, including, of course, increases in building and public works. In allocating these increases, departments had been instructed to give special attention to the needs of areas of high unemployment. He had sympathy with Mr. Woodburn's view and it was that point, the stage at which increased orders were to be placed, that departments were directed to observe.

SPREADING INDUSTRY

Some criticisms were made respecting the impact made by the Distribution of Industry Act, 1958. Answering Mr. Douglas Jay (Labour), who condemned the results of the Act as " meagre," Mr. F. J. Erroll, the Economic Secretary to the Treasury, said that 67 firm and eligible applications had been made for financial assistance to the Development Areas Treasury Advisory Committee. Of that number, 16 applications had so far been approved, but, he told Mr. Ernest Fernyhough (Labour), he could not inform the House of the value of the Government's grants without notice.

Other questions were put to the President of the Board of Trade. Sir David Eccles told Mr. R. E. Prentice (Labour) that he agreed with Mr. Prentice that the general state of investment in the private sector of industry was an important factor, but said that there had not been much time since the passing of the Act to get it going. Further results would be obtained gradually. To Mr. Hugh Gaitskell (Labour), who asked that further special action should be taken in areas of very heavy unemployment and that, in particular, consideration should be given to declaring north-west Wales a development area under the earlier Acts, Sir David said he would take note of these suggestions. He told Mr. Joseph Grimond (Liberal) that differences in the transport costs involved in placing a factory in certain areas were one of the considerations taken into account by the Treasury committee.

SAFE ROAD SURFACES

Replying to Mr. John Rankin (Labour/Co-operative), who drew the Minister's attention to the concern felt by the Scottish Co-operative Transport Executive regarding the dangerous conditions which exist on many Scottish roads, Mr. John Maclay, the Secretary of State for Scotland, said that the current specification, to which new road sufaces were constructed, provided for an anti-skid finish combined with satisfactory wearing and riding qualities. Conditions on particular roads were the responsibility of the highway authority concerned. He was satisfied in general, however, that the organisation and equipment of these authorities, together with the equipment which was held by his department at various points throughout Scotland, were adequate to maintain the roads in a safe state in all but the most exceptional weather conditions.

PROGRESS AT PRESTWICK

Developments at Prestwick Airport, Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, told Mr. John Rankin, were estimated to cost between £2 million and £3 million. The improvements would include the extension of the main runway and the associated taxi-track to a length of about 9,800 ft; the provision of a new terminal area, including a new apron; the construction of a new control tower and fire station; and the diversion of the A77 road. The construction of a hotel was under consideration. In this connection, the Redbrae site was much the better of the two which had been suggested.

DECCA NAVIGATOR SYSTEM

Information was sought by Mr. Paul Williams (Independent Conservative) regarding the instructions being given to the British delegate to the forthcoming International Conference on Civil Aviation Organisation, especially in regard to navigational aid. He was told by Mr. John Hay, a Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, that the delegate would be instructed to advocate strongly the adoption of the Decca Navigator System as the only available short-range navigational aid which effectively meets the requirements for the safe and efficient use of air space in areas of high-traffic density.

PART-TIME TECHNICAL COURSES

Mr. Michael Stewart (Labour) asked the Minister of Education what conclusions had been reached by the Central Advisory Council for Education regarding the wastage of students in part-time courses at technical colleges. He pointed out that the inquiry had been started about a year ago and wondered when the Council's report was going to be issued. Sir Edward Boyle, Bt., the Parliamentary Secretary to the Ministry of Education, said that the Council had not informed the Ministry separately regarding their conclusions, but would deal with them in their main report, which would be issued by the end of the summer.

Management

WHAT THE FUTURE HOLDS

for COAL

AND ELECTRICITY

In the first report of this series, on page 6 of our issue of 2 January, consideration was given to the effects of exports, raw materials, and wages and working hours, on industry as a whole. In the second, third, and fourth reviews, on pages 40, 76, and 110 of our issues of 9, 16, and 23 January, an examination was made of particular industries: aircraft, shipbuilding, motor vehicles, textile machinery, locomotives and rolling stock, machine tools, and agricultural machinery. This report, which concludes the series, is concerned with coal and electricity, light electrical goods, wires and cables, and general and constructional engineering.

UNDER the combined influence of mild weather, industrial recession and rising consumption of oil, the coal situation in this country has radically altered during the past year. The National Coal Board entered 1958 with prospects of a further increase in production (total output in 1957 was 1·6 million tons higher than in 1956), a high level of stocks and a rate of output already higher than the capacity of the market to absorb it.

Stocks held by the NCB at the end of December, 1957, amounted to 8·6 million tons compared with 2·9 million at the end of December, 1956. Distributed stocks were also nearly a million tons higher at 18·8 million tons. In spite of a more severe winter than that experienced in the first few months of 1957, stocks did not diminish very greatly, and from the end of April began to rise rapidly. By the end of November, 1958, distributed stocks stood at 19 million tons while those on the hands of the NCB amounted to the staggering figure of 17·6 million tons. The latter figure is not only 9 million tons higher than the year previous but also about 14 million tons higher than the "normal working stocks" the industry likes to hold. These increases in stocks have taken place in spite of a steady drop in output. It is estimated that total production in 1958 will amount to no more than 214 million tons, a 9 million ton drop on the previous year, largely due to the ending of the Saturday shift. Consumption, on the other hand, may be as much as 10 million tons below production.

With inland consumption declining, there has also been a decline in exports. The demand for coal on the Continent has declined, as it has in Britain, as a result of mild weather and steadily slackening industrial activity. As in the United Kingdom it has also been affected by rapidly rising sales of fuel oil. In the immediate post-war period there was on the continent of Europe a substantial market for coal exports from the United Kingdom if these had been available. This situation has now completely changed. In addition to declining demand during the past year, increasing quantities of coal both from Poland and the United States have been available at competitive prices. The sharp fall in trans-Atlantic coal freight rates during 1957 meant that at least in the early part of 1958 American coal shipped under one year contracts could sell even in the Ruhr for less than Ruhr coal. Polish coal was reported in May, 1958, to have been offered in some cases at 30*s* a ton below the British home price.

The emphasis, which in recent years has been entirely placed on maximum output, to some extent regardless of economy, has thus shifted to a planned withdrawal consistent as far as possible with maximum economy.

It has become apparent during the last year that sales of fuel oil, which have continued to expand, are now being made at the expense of coal. It has previously been held that imports of oil were essential to make up the gap between the total British energy demand and that which could be satisfied by coal production.

Meanwhile the Government have been maintaining that their forecasts of the country's energy demands in the middle and the late 1960's still stand, and that unless a much lower rate of industrial expansion is to be accepted, these would presumably remain. Any measures to be taken by the Coal Board to meet their immediate financial difficulties caused by the accumulation of stocks must therefore not in any way prejudice the long term requirements. In a debate in the House of Commons early in December, Mr. Maudling predicted that by 1965 Britain will still be using the equivalent of 300 million tons of coal a year and exporting the equivalent of 10 million tons. He said, however, that the estimates of coal demands as 228 million tons in 1960 and 240 million in 1965 now appeared unlikely to be fully realised. This was at least in part due to growing competition from oil.

Early in December the NCB announced plans for cutting back production by the closure of 36 pits and at the same time a cut-back in opencast output of the order of 3 million tons. The miners themselves suggested at first that the cuts should fall exclusively on opencast working. In view of the fact that a large part of the profits of the NCB come from opencast working this would clearly be an uneconomic proposal. It is estimated that the Board's proposals would make a difference of about 6 million tons a year, evenly divided between opencast and deep mined production. The Board estimates that the total output in 1959 at the reduced rate will be about 203 million tons and the demand will probably be not more than 200 million tons. The surplus of 3 million tons will be added to existing stocks which should thus rise to about 22 million tons by the end of 1959. This the Board regards as the most that it can hold.

Early in the New Year, the NCB chairman, Sir James Bowman, described the situation as "a struggle for the life of coal in Great Britain." In spite of earlier Government optimism, the NCB no longer believes that demand will reach the anticipated figure of 240 million tons by 1965, but expects over the next few years a level of demand lower than that of 1955 and 1956. The emphasis will shift towards making coal competitive on price with oil—which was responsible for about 5 million tons of the total fall in demand for coal in 1958.

The NCB thus certainly faces the most difficult situation it has encountered since the war, and possibly the coal industry has not faced such difficulties during the past 30 years. In spite of the fact that the labour force of the NCB has been steadily declining, the latest closures will probably result in between 12,000 and 13,000 men being declared redundant.

The output statistics for coal mining machinery which have been available hitherto, have been discontinued and a new series not yet started, so that firm figures for output are not available for the past year. The proportion of coal got by mechanical means rose quite rapidly during 1957, and it was expected that this rise would continue during 1958. Deliveries of coal cutters to the NCB appear to have been maintained at a higher level than during 1957 and it is probable that this will continue up to a point. The declared intention that the coal industry should become somewhat smaller and more efficient means that modernisation will continue. The NCB estimate that an annual investment in the region of £100 million will continue to be necessary.

Investment in the coming year, as in 1958, is expected to be about £104 million. How far this will be able to supply a market for the manufacturers is less certain. What is clear is that overall exports of mining machinery during the first three-quarters of 1958 were somewhat lower than for the corresponding period of 1957, though higher than in 1956. One manufacturer of continuous mining machinery has been forced to close one factory owing to shortage of orders which suggests that the position is not altogether happy at present. In an industry of the scale of the coal mining industry, however, long term plans cannot be switched from month to month, and since in the long term modernisation is essential for the industry to be competitive with fuel oil, continuing mechanisation is inevitable.

The electricity supply industry can face a much less clouded future. At the end of March, 1958, the Central Electricity Generating Board had 24,320 MW of plant in service. Between 1959 and 1964 the industry is planning to put in about 12,250 MW of new plant. Though some of this new capacity is required to replace old plant, for the most part it represents a net addition to the Board's system. In December, 1958, the text was published of the Electricity (Borrowing Powers) Bill by which the permitted

United Kingdom: Deliveries of Electrical Plant and Machinery

—	Units	Total					For export				
		1954	1955	1956	1957	1958	1954	1955	1956	1957	1958
Hydraulic turbines	Thousand b.h.p.	507·6	446·4	165·6	817·2	793·2[1]	404·4	303·6	114·0	709·2	694·9[2]
Steam turbo-alternators (10 MW and over)	MW	2,342·4	2,619·6	3,372·0	2,697·6	2,617·0[1]	772·8	828·0	834·0	828·0	1,250·7[2]
Steam turbines (less than 10 MW)	MW	214·8	192·0	170·4	252·0	216·6[3]	98·4	78·0	48·0	82·8	56·4[3]
Rotating electrical machines:											
1-250 h.p. kVA or kW	£1,000	26,808	31,032	36,048	38,664	38,994[3]	5,244	6,096	6,900	7,444	6,612[4]
Over 250 h.p. kVA or kW	£1,000	7,404	8,580	9,864	11,388	10,983[3]	2,544	2,460	2,784	3,444	2,949[3]

[1] Estimated on first nine months. [2] Estimated on first six months. [3] Estimated on first eight months.

borrowing powers for capital investment by the Electricity Council, the North of Scotland Hydro-Electric Board, and the South of Scotland Electricity Board will be raised by £1,060 million. These Boards were originally authorised to spend just over £280 million in 1958 on fixed capital equipment. During the course of the year they were authorised to spend rather more on work which could be completed rapidly. By the early 1960's investment on production and distribution of electricity may well have reached £400 million a year. The total capital requirements of these Boards from 1958 to the end of the 1964/65 financial year have now been put at £2,432 million.

There were, however, some indications that the pace of development may be somewhat slower than it has been hitherto since the war. Sales of electricity rose from 32,700 million units to 72,700 million units between 1947/48 and 1957/58. Some of the growth resulted from efforts to overtake post-war arrears so that even discounting the possibility of recession this rate of progress may well not be maintained.

The target of 5 million to 6 million kW of nuclear power remains, but will be delayed by about 12 months, that is, until about 1966 due to the capital investment restrictions imposed on the electricity supply industry in 1957. As a result of the increase in the electrical output of the planned nuclear power stations this capacity will now be provided by not more than 12 to 14 stations.

The rise in capacity of individual power stations and generating units continues. Sites are now being developed for capacities of 1·5 million to 2 million kW. As a result an average of only three new power stations will be started each year from 1959, although the capacity of new generating plant brought into service will not be less. The Electricity Council states that this should lead to a reduction in the cost of building and civil engineering work and also a reduction in time taken for construction. A warning of what this would mean to the suppliers of generating plant was given last April by Sir Christopher Hinton, Chairman of the Central Electricity Generating Board. Although no less money would be spent on power stations, this money would be spent in a smaller number of parcels. The smaller number of power stations started each year represented a serious change from a few years ago when ten or more stations were ordered each year. This, according to Sir Christopher, meant that the electrical industry must re-organise itself to avoid getting into the sort of difficulty which had beset the aircraft industry.

The largest generating unit to be installed so far by the Central Electricity Generating Board (120 MW) was brought into operation at the Blyth Power Station in December. This generator, probably the most efficient yet in operation in Britain, is only the first of four machines with which the station will ultimately be equipped. A second station at the same site is already authorised and will contain generators of 275 MW capacity. In the same month it was announced that C. A. Parsons and Company had been awarded a contract worth well over £4 million to build a turbo-generator giving a capacity of 550 MW, to be installed at the Thorpe Marsh Power Station near Doncaster, and scheduled for commissioning in 1963.

In considering both production and exports of such large items of capital equipment as large turbo-alternators, it is essential to take one year with another. In view of this the accompanying table will be seen as showing that the general level of both output and exports of heavy electrical machinery has steadily risen over the period covered. It was stated by Lord Chandos in May of last year that the United Kingdom electrical industry received large orders during 1957 for generating equipment and that the industry remained, in most aspects of the export market, strictly competitive. He said, however, that foreign competitors were undercutting United Kingdom exporters by more than 20 per cent in some cases and that this would lead to difficulties in the export markets. In spite of this, important export orders have been secured during the past year and provided the industry can adapt itself to the increasing size of unit required the future looks reasonably bright.

United Kingdom: Exports of Light Electrical Goods and Apparatus and of Telegraph and Telephone Cables (Value £1,000)

	1956	1957	1958[1]
Electronic valves and radio, television and sound recording apparatus	33,589	34,240	32,923
Telephone and telegraph apparatus	19,719	22,736	22,336
Electric light bulbs and tubes	2,631	2,712	2,569
Electric light apparatus and appliances	5,627	5,074	3,868[2]
Batteries, primary, complete	4,667	4,674	5,159
Accumulators, complete	3,991	3,183	3,200
Electrical cooking and heating appliances	4,614	4,158	3,931
Electrical instruments	2,576	2,760	2,909
Electromedical apparatus	1,719	1,800	1,865
Refrigerating machines	14,801	14,638	15,392[2]
Vacuum cleaners	1,697	1,770	1,505
Total	95,631	97,745	95,657
Telegraph and telephone cables and wires:			
Submarine	2,051	4,274	835
Others	10,203	10,897	6,244
Other descriptions of cables:			
Cotton, silk or artificial silk insulated	583	409	512
Enamel, glass or asbestos insulated	1,223	1,093	1,159
Paper insulated	10,548	8,729	7,892
Rubber insulated	6,470	6,450	5,349
Thermoplastics insulated	1,777	2,371	2,288
Other	2,544	2,168	2,608
Total	35,399	36,391	26,887

[1] Nine months annual rate. [2] The figures for 1958 are not completely comparable with those of previous years.

What the Future Holds for

LIGHT ELECTRICAL GOODS, WIRES AND CABLES

THE outlook for manufacturers of light electrical equipment and radio and television sets has been considerably improved in the last few months by the progressive relaxation of hire purchase restrictions. The diagrams on page 146 show that, in spite of the restrictions in force in the early part of 1958, several items of equipment registered an expansion of sales compared with 1957; for example, in the diagram showing production of refrigerators, the 1958 figure is based on the first six months only, yet shows a very large increase over the output for 1957. Production of electric vacuum cleaners was more or less static while, based on the first nine months, output of domestic electric washing machines rose very appreciably from the figure achieved in 1957.

The manufacturers of television receivers estimated early in 1958 that their sales for the year would total between 1·6 million and 1·7 million receivers compared with 1·8 million in 1957. Up to the middle of the year production had been running at a higher annual rate than this estimate but was believed to have been cut back slightly in the two months preceding the Radio Show. Later in September, however, orders from retailers were stated to have been running at or only slightly under the levels of 1957.

As from 16 September a wide range of goods was released from hire purchase control, including radio and television sets, radiograms, tape recorders, and domestic electric, gas, and other appliances. For the radio and television industry the most important effect of the relaxation was the reduction in the initial rental payment required from nine months to four months. Shortly after the relaxations were announced the most marked effect was reported to be on radio and television rentals. This led to complaints from the radio and television industry that the change had been detrimental to direct sales and had promoted rental to a position where it was claimed it might account for three-quarters of total current business. Possibly as a result of agitation behind the scenes all hire purchase controls were ended at the end of October. While members of the Hire Purchase Trade Association were recommended at the time not to seek deposits of less than 10 per cent for domestic equipment, radio, and television receivers, there was an immediate rush of low deposit terms announced by many dealers. The move was widely welcomed both by the radio industry and by the manufacturers of electrical appliances; it was hoped that the increased volume of business which would certainly result would enable economies of scale in production and would thus help export business.

The estimated export figures for 1958 show that some form of help was badly needed. In almost every category in this field exports were either static or slightly lower compared with 1957.

The relaxations in credit restrictions did in fact have a marked effect in some fields. A boom in sales of domestic appliances had already been reported by the Area Electricity Boards during the first half-year, largely as a result of concessions made in the Budget. Some startling figures were given in order to show the effect of these on sales in the quarter ended June, 1958. Compared with sales in the corresponding quarter of the previous year, sales of refrigerators rose by 91 per cent; those of immersion water heaters by 37·7 per cent; and of washing machines 13·6 per cent. The most startling of these figures is that for refrigerators. During the first quarter of the year sales of refrigerators declined slightly from the previous year. During April, however, sales rose by 63 per cent and during May by as much as 183 per cent compared with the year previously. This does not of course represent the whole picture; for example, while the Area Electricity Boards are responsible for about 75 per cent of cooker sales, they are responsible for only 20 to 25 per cent of washing machine and refrigerator sales. Refrigerators are still owned by a comparatively small percentage of households. In 1946 both washing machines and refrigerators were owned by 2 per cent of households; the washing machine figure rose much more rapidly to 25 per cent by 1957 while a refrigerator was still owned only by about 10 per cent of households. Clearly weather conditions in the early part of 1958 did not account for the greatly increased sales of refrigerators, so that the Budget must have had a very marked effect.

Recent years have also shown a very marked increase in sales of spin dryers. Although firm figures are not available it has been stated that less than 200,000 were in use at the end of 1957 but that production is rising rapidly. It is interesting to note that it has been reported that production of spin dryers in Germany has risen from a total output of 61,000 in 1953 to

Continuing What the Future Holds

about 750,000 in 1957. This is clearly potentially a very important market for the electrical appliance manufacturers.

The final ending of hire purchase controls in October led to a very strong rush on the Area Electricity Board's showrooms to the extent that credit facilities were barely adequate to cope with the demand. It is probable therefore that electrical appliance manufacturers will face a period where sales are limited rather by available funds for credit facilities than by either production capacity or demand.

The changing background of the radio and television manufacturing industry has been stressed during the past year. The chairman of A. C. Cossor Limited drew attention to the contracting profit margins in the industry. While wages and other costs have steadily increased, prices have been progressively reduced. The intense competition between manufacturers has been produced by the expansion of manufacturing capacity caused by the post-war boom, particularly in television. This competition was largely technical in the first stages but in recent years the general standard of performance has become so high that technically there is much less to choose between makes of set.

Under these circumstances price becomes an essential factor and it is on price that recent competition has been based. It was stressed that the larger manufacturer enjoys under these circumstances a very real advantage. Several manufacturers have felt this situation keenly; during the past two years two of the best known and oldest manufacturers in the trade have arranged for their brands to be supplied by their former competitors, while several lesser known makes have disappeared from the market altogether. Purchase tax continues to be a bone of contention of the radio industry, and there is little doubt that the manufacturers have a real grievance. The continuing high level of purchase tax liable to sudden alteration, coupled with restrictions of hire purchase, have produced a thoroughly unstable home market in which steady development has been difficult.

The export ratio in both the radio and radiogram and the television field is comparatively small, particularly in television sets. Exports of radios and radiograms have steadily declined over the past few years. At the annual general meeting of Pye Limited, in September, the chairman referred to the growing intensity of competition in export markets. In spite of this, during the last five years the value of British television equipment exports has increased more than three times. The increase of exports of transmitters, receivers and cathode ray tubes amounts to about £1·3 million, the rise being from about £500,000 in 1953 to £1·8 million in 1957. In many possible markets United Kingdom manufacturers face import restrictions.

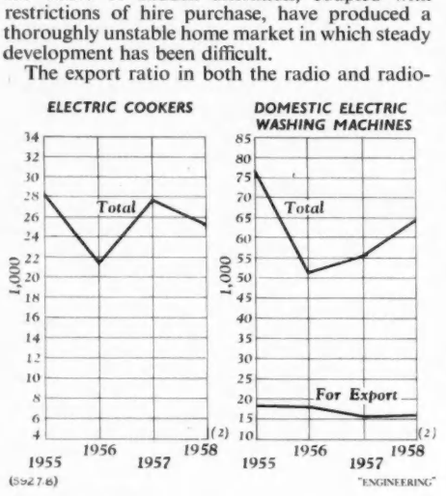
Television is normally a possibility only in countries with sizeable concentrations of population and a relatively advanced industrialisation. In most cases such countries have protected local electrical industries. In such circumstances British firms are obliged to manufacture locally. A major example of this is Australia, where there is an embargo on bulk importation of finished receivers. In such a case there is no choice and most of the major British exporters are now manufacturing or assembling through Australian associate companies.

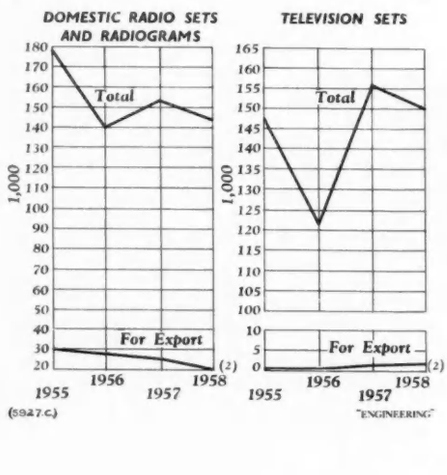
As in other fields the setting up of the European Common Market and the breakdown of the Free Trade Area negotiations will pose increasing problems. For example, Mr. Leslie Gamage, chairman of the General Electric Company, referred to the disadvantageous position of the United Kingdom lamp industry compared with its Dutch and German competitors. He pointed out that if the proposed Free Trade Area does come into existence, this country's market would expand considerably while at the same time the home market would be opened up to foreign competition. His view was that the answer must be to produce larger quantities of lamps and a smaller number of types both for the home market and for export.

The last two months of 1958 were marked by three moves towards mergers in the cable making field. Early in October it was announced that the boards of Associated Electrical Industries and W. T. Henley's Telegraph Works had concluded negotiations to amalgamate the cable and other manufacturing resources of the two companies. The new group so formed would account for over 20 per cent of cable production for the United Kingdom home market.

Before Christmas a further step was announced with an offer by AEI for the issued capital of the London Electric Wire Company and Smiths. The chairman of AEI, Lord Chandos, stressed that neither of these offers were takeover bids or financial deals but straightforward amalgamations which were directed towards a rationalisation of the United Kingdom cable making industry. Early in November British Insulated Callender's Cables made an offer to acquire the whole of the issued share capital of Telegraph Construction and Maintenance Company on a share exchange basis. This offer, is very likely to be accepted.

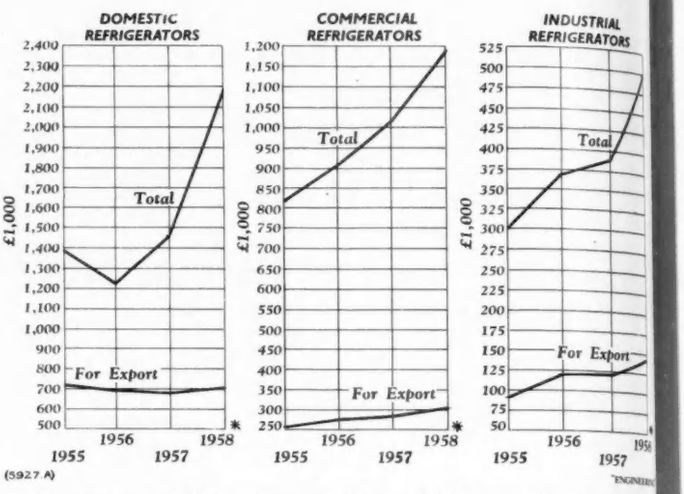
The background to these deals is undoubtedly the long term problem of excess capacity. In the words of Lord Chandos, this has been growing gradually for a period of years but has become more acute over the past eighteen months. It is a long term phenomenon independent of current industrial recession. At the same time the present recession has almost certainly made matters worse. The table given





Monthly output of refrigerators in the UK in £ thousand.

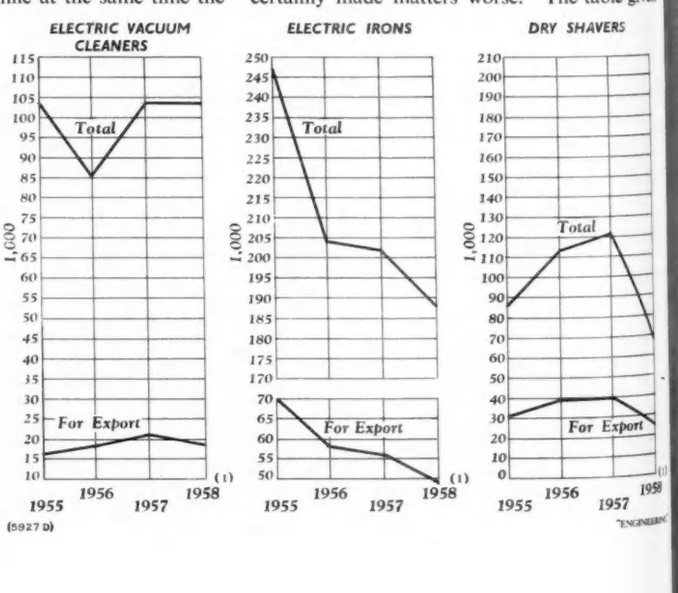
* Estimated on first six months



Average monthly output of domestic appliances in £ thousands.

(1) Estimated on first six months

(2) Estimated on first nine months



on page 145 shows how drastically the estimated exports of almost all types of wires and cables have declined in 1958 compared with the previous two years. While figures for sales by the United Kingdom industry as a whole are not so far available, it has been stated that the recession has caused a sharp fall in home demand. If this is anything like as serious as the drop in exports the cable-making industry has been experiencing a very difficult year. An important factor in the cable making industry is the predominance of a small number of very large contracts; an example which may be quoted is one announced last October for £893,000 for the construction of the Canadian section of a new transatlantic telephone cable forming part of the global Commonwealth link; this has been awarded by the Canadian Overseas Telecommunication Corporation to Submarine Cables Limited, a company owned jointly by Siemens Edison Swan Limited (a member of the AEI Group), and the Telegraph Construction and Maintenance Company Limited.

While rationalisation in the face of excess capacity has been stated as the reason for these amalgamations there have also been suggestions that AEI, for example, is relying on an improvement in the demand for cable in the future and hoping to secure a better competitive position by increasing the scale of their business. In the home market the cable-making industry, which suffered from the cut-back of the nationalised industries investment programme, can almost certainly look forward to a recovery in this field over the next few years if present plans go ahead. Demand has, however, been declining also from the under-developed countries which should potentially offer the best market overseas and this may continue to present a severe problem.

In January last year the need for a new organisation to act as a forum at which the problems of the cable-making industry could be discussed led to the formation of the Electric Cable Makers Federation. The initial membership of this federation was about 40 British cable makers claimed to comprise almost the whole of the industry. This new body was intended in no way to replace existing organisations such as the Cable Makers Association, nor was it intended to concern itself with price fixing or any other related activities.

If present trends continue the cable-making industry looks like being able to accomplish a rationalisation and integration without the public fuss and bother which has accompanied such proposals in, for example, the aircraft industry. In view of the background to the industry the accomplishment of this rationalisation is highly desirable.

What the Future Holds for
GENERAL AND CONSTRUCTIONAL ENGINEERING

In a year popularly labelled as one of recession it is again interesting to note how astonishingly stable the index of industrial production has remained. On figures available for the first eight months of 1958, the index for all industries fell to 104·5 from an average of 106 for the corresponding period of 1957. Over the same two periods the index for all manufacturing industries remained static at 106·5, the principal decline being in construction. Production in the engineering and allied industries rose from 109 to 110·5, the most prominent feature being the steady rise in vehicle production (the index for this sector rose from 112·5 to 118·5). It is perhaps important to realise, therefore, that what is currently labelled as a recession is in fact no more than a standstill taken over the whole economy. Against this background certain sectors have in fact been expanding as fast as would be expected in a period of overall expansion.

In the wide field of engineering industries not already covered by articles in this series, there have, however, been some depressing features over the past year which seem likely to continue. Exports last year of the products listed in the accompanying table declined slightly compared with 1957. Though the decline was in general slight, there was a moderately severe fall in exports of excavating machinery and also in sewing machines. Industries in which exports have been rising rapidly in recent years, for example, cranes, hoists and other lifting machinery, and office machinery, have been unable during the past year to maintain this expansion. In the case of cranes the diagram which accompanies this article (page 148) should be treated with some caution, since the estimate is based on figures which are available only for the first quarter of 1958.

In the office machinery field the total production of typewriters fell to an estimated level near to that of 1956, though production of accounting and similar machinery and other categories of office machinery continued a steady but slow rise. In this field the most important event of last year was the first exhibition held in this country devoted entirely to electronic computers. This exhibition showed convincingly that computers in this country have advanced from being scientific marvels to being able to make a major contribution to industry, both in their production and their application. The adoption of computers in this country has been very much slower than in the United States and it is by no means certain the British industry has not been a great deal wiser than American concerns in being more cautious. It has been stated that during the boom period, United States companies either bought or hired well over 1,000 computers, in many cases merely to keep up with their neighbours. The computer exhibition made it clear that British manufacturers after a slower start are now well established in the field and able to offer equipment which is competitive in any market. There is little doubt that over the next two or three years computers will make an increasing contribution to United Kingdom exports.

Bicycles continue to be a depressing feature of engineering industry, total production continuing its decline during 1958 to a monthly average figure of 175,000, compared with an average of 297 000 a month in 1955. The greater part of this decline has been in the export field and exports again declined during 1958. In spite of the drastic fall in exports to the United States which has taken place over the past few years, that country still remains the largest single market for cycles. During the first nine months of 1958, 176,091 cycles were exported to the that country compared with 161,600 over the same period of the previous year. The United Kingdom cycle industry has, however, been working at less than half its capacity, and there is no great expectation of ever returning to the level of production enjoyed in 1950 and 1951.

In Birmingham, one of the major centres of cycle production in this country, between 3,000 and 4,000 cycle workers have been made redundant in the last few months and there is little expectation of their being employed in this industry again. It has been stated that the re-organisation of the industry which has taken place during the last two years which has resulted in larger productive units has also included some deliberate contraction. Apart from the United States where the fall in imports has been largely due to competition from other countries, notably Germany, the principal reason for contracting exports of cycles has been the imposition of import restrictions by countries which were formerly the industry's best customers.

In spite of this the fact remains that Britain still has the largest cycle industry in the world and is now turning, though it may be thought somewhat belatedly, to the production of the mechanised bicycle. Raleigh introduced in November the first British moped to be made on a large scale. It has been reported, however, that imported mopeds have declined in popularity in the past year. German exports of mopeds in the first half of 1958 were 65,934, compared with 109,144 in the first half of 1957.

United Kingdom: Exports of Some Industries Classified as "General Engineering" (Value £1,000)

—	1954	1955	1956	1957	1958[1]
Air and gas compressors and exhausters	5,172	5,398	6,277	6,713	5,644
Boot and shoe machinery	958	1,166	1,036	1,198	1,341
Cement making machinery	989	1,137	1,016	1,579	2,019
Centrifugal drying machinery	709	877	781	1,107	1,035
Concrete mixing machinery	1,117	1,597	1,775	1,501	1,037
Condensers	890	847	747	974	861
Cranes, hoists and other lifting machinery	13,713	12,370	14,292	16,035	16,908
Excavating and similar digging machinery	14,893	18,902	22,658	22,251	19,428
Fans, power driven	2,574	2,795	3,408	3,468	3,708
Food preparation and sterilising machinery	4,238	4,533	5,351	5,215	5,181
Furnace plant	1,404	3,190	2,538	3,118	4,301
Gas and chemical machinery	2,487	2,807	2,235	3,535	5,229
Grain-milling machinery	2,041	2,284	2,762	2,443	2,643
Hydraulic machinery	789	1,250	1,270	947	1,049
Laundering and dry-cleaning machinery	6,757	7,485	7,376	7,119	7,749
Lawn mowers	1,827	2,033	1,691	1,484	1,697
Office machinery	12,192	14,787	16,321	19,005	19,341
Packing, packeting and labelling machinery	3,523	4,819	5,675	6,170	6,656
Portable power tools	4,175	5,302	5,994	6,010	5,753
Printing and bookbinding machinery	9,061	9,848	10,300	10,324	9,331
Pulp and paper making machinery	4,086	4,081	3,221	3,208	3,803
Pumps	13,250	13,803	16,143	16,252	17,084
Road rollers	1,658	2,086	2,454	2,345	1,476
Sewing machines and parts	8,046	9,699	10,665	11,230	9,408
Sugar making and refinery machinery	3,656	2,270	2,352	2,847	2,196
Tobacco and cigarette making machinery	4,273	3,842	3,520	3,985	3,965
Weighing machinery	1,495	1,707	1,892	1,913	1,932
Welding machinery	1,797	1,895	2,530	2,682	2,683
Woodworking machinery	1,865	2,128	2,394	2,640	1,659
Ball and roller bearings	3,864	4,520	5,411	5,971	5,976
Ophthalmic instruments	794	781	616	731	632
Medical and surgical instruments	2,071	2,268	2,350	2,431	2,536
All other scientific instruments	11,285	12,826	14,709	17,348	17,687
Clocks and watches	1,342	1,604	1,698	1,940	1,787
Total	148,991	166,937	183,458	195,719	193,735

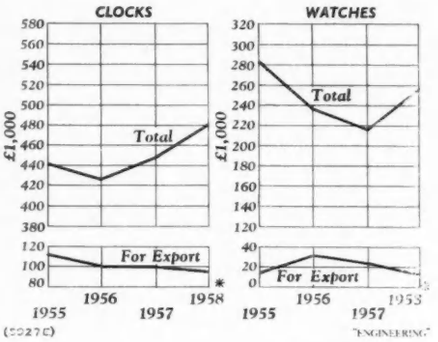
[1] Estimated on first nine months.

Continuing What the Future Holds

Output of earthmoving machinery, other than excavators, has continued to rise slightly in spite of a decline in exports. It is to be expected that this output will continue to rise, bearing in mind the continuing investment in road building in this country. The road building programme has been gathering way during the past year. Early in December the first of the new high speed roads, the Preston by-pass, was opened by the Prime Minister; the London-Birmingham motorway is now well in hand and should be completed by the end of October. 1959, and two-thirds of the authorised building of 75 miles of dual carriageway on the Great North Road is already finished or under construction.

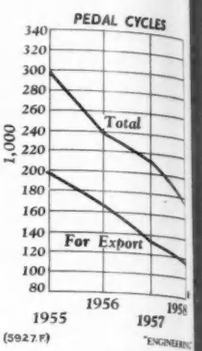
During this year work will start on the Doncaster and Stamford by-passes, and the Lancaster by-pass should be ready by the end of 1959. It is also intended to start during the coming year three of the viaducts needed to carry the Birmingham-Preston motorway. In addition an expansion of local authority work on improving minor roads is envisaged by the Government.

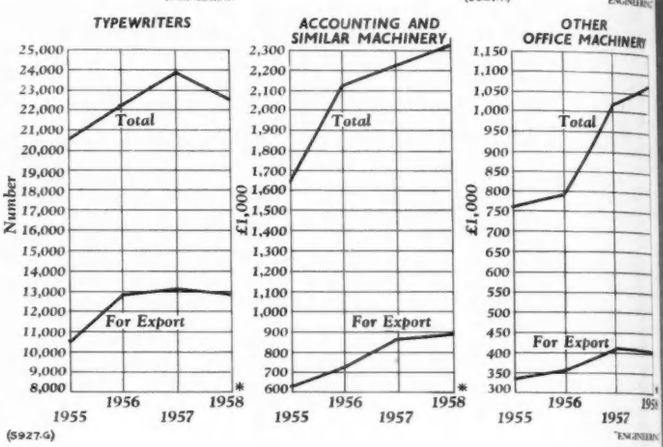
The value of building and civil engineering work carried out in Great Britain by all agencies in the first nine months of 1958 rose slightly to £1,613 million compared with £1,604 million for the corresponding period in 1957. The level of employment in this field has again declined, the maximum in 1958 (July) being 1,049,000 compared with the peak figure for 1957 of 1,067,000. Approvals for industrial building again fell in the first three quarters of 1958, both in number (1,587 compared with 1,829 in the corresponding period of 1957) and in area (34,910,000 sq. ft. compared with 50,199,000 sq. ft in 1957). The outlook for builders and contractors is considered to be much brighter for the coming year. The loosening of controls in the summer and autumn of the past year has led to increased demand for consumer goods, which should lead to an increased demand for industrial building. Further, the reduction of bank rate and the relaxation of credit restrictions has again given the builders and contractors the money to finance new orders. From the point of view of the builders, possibly the most important factor in the past year has been the relaxation of house purchase restrictions and the Government's plans on easier mortgages. Builders look forward to a better year in 1959.



Average monthly output of clocks, watches and pedal cycles in the UK.

* Estimated on first nine months



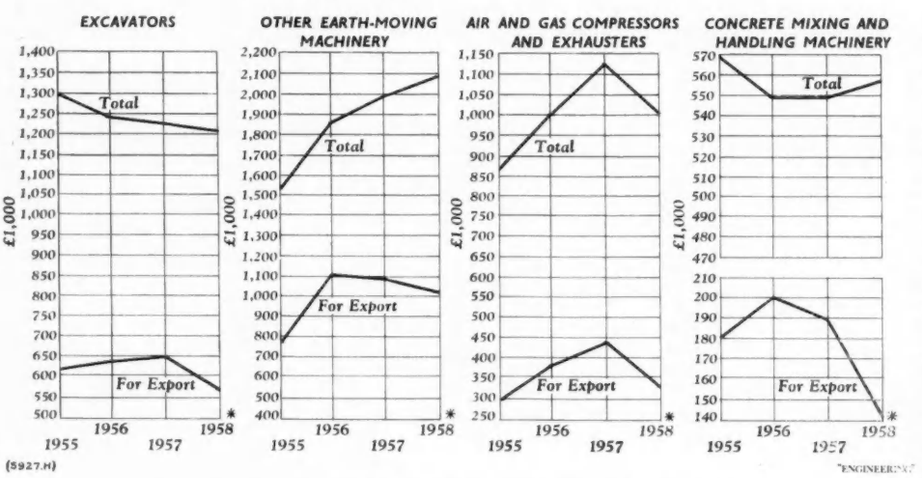


Average monthly output of office machinery in the UK.

* Estimated on first nine months

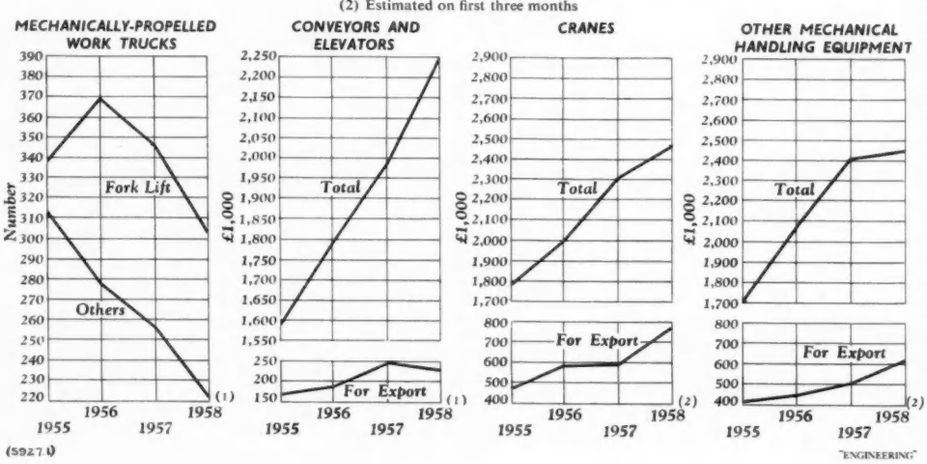
Average monthly output of civil engineering and contracting plant in £ thousand.

* Estimated on first six months



Average monthly output of mechanical handling equipment in the UK.

(1) Estimated on first eight months
(2) Estimated on first three months



Overseas work by British contractors continues to increase. In the year ending March 1958, the value of work carried out in this field was £114 million, compared with £94 million in the previous year and £87 million for the year before. The value of new contracts obtained totalled £119 million, an increase of £17 million on the previous year. An encouraging feature is the reversal of trends in the obtaining of new orders; during the previous year the value of new contracts obtained dropped by £7 million. In the previous year a feature had been the rise in contracts obtained in the dollar area which helped to offset a fall in the sterling area; during the year to March, 1958, the value of work obtained in the sterling area, including most countries in the Middle East, increased substantially and a total of £84 million of work was obtained compared with £54 million in the previous year and £70 million in the year 1955-56. The amount of new work obtained in the Middle East also shows a considerable increase.

One of the most spectacular projects started in the United Kingdom during the past year has been the Forth road bridge; the total cost of this project has recently been estimated at about £16½ million and tenders have been accepted both for the superstructure and for building the foundation and piers. It is hoped that the bridge should be in operation in 1962. A further major scheme is the duplication of the Blackwall tunnel commenced in April, 1958 and estimated to cost £7·7 million.

MEETINGS AND PAPERS

British Institution of Radio Engineers

LONDON
Inaugural meeting of the Computer Group. London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Wed., 4 Feb., 6.30 p.m.
MANCHESTER
"Recent Astronomical Research Using Radio Waves," by Dr. H. P. Palmer. North Western Section. College of Technology, Sackville Street, Manchester. Wed., 4 Feb., 6.30 p.m.

British Interplanetary Society

LONDON
"High Energy Fuels and Rocket Propulsion," by Dr. F. Fitzgerald. Caxton Hall, off Victoria Street, S.W.1. Sat., 7 Feb., 6 p.m.

Chemical Society

BIRMINGHAM
"'Birdcage' Molecules," by Dr. F. G. Mann. Birmingham Branch. Chemistry Department, The University, Birmingham. Fri., 6 Feb., 4.30 p.m.
CAMBRIDGE
"The X-Ray Analysis of Complex Structures," by Mrs. D. Hodgkin. Cambridge Branch. University Chemical Laboratory, Lensfield Road, Cambridge. Fri., 6 Feb., 8.30 p.m.

Engineers' Guild

LONDON
Luncheon Meeting. Metropolitan Branch. Constitutional Club, Northumberland Avenue, W.C.2. Wed., 4 Feb., 12.20 for 12.50 p.m.
EDINBURGH
"Family and Personal Associations with Lighthouses," by D. Alan Stevenson. Luncheon Meeting. East of Scotland Branch. Scottish Liberal Club, 109 Princes Street, Edinburgh. Mon., 2 Feb., 12.45 for 1 p.m.

Helicopter Association

LONDON
"Some Engineering Aspects of Helicopter Assessment Trials," by H. J. Webb. Royal Aeronautical Society, 4 Hamilton Place, W.1. Fri., 6 Feb., 6 p.m.

Illuminating Engineering Society

EDINBURGH
"Artificial Lighting for the Paper Making Industry," by L. C. Rettig. Edinburgh Centre. YMCA, 14 South St. Andrew Street, Edinburgh. Wed., 4 Feb., 6.30 p.m.
NEWCASTLE UPON TYNE
Swan Memorial Lecture: "Eightieth Anniversary of the First Public Demonstration of Swan's Filament Lamp," by J. N. Aldington. Newcastle upon Tyne Centre. Literary and Philosophical Society's hall, Westgate Road, Newcastle upon Tyne. Tues., 3 Feb., 6.15 p.m.

Institute of Marine Engineers

LONDON
Discussion on "Watchkeeping, Maintenance, Repair and Survey of Ships." Student Meeting. Mon., 2 Feb., 6.30 p.m.*
LIVERPOOL
Annual General Meeting. "Heavy Oil Burning," by Dr. J. S. Clarke and G. J. Hudson. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Mon., 2 Feb., 6 p.m.
"Launching of Ships," by R. S. Hogg. Merseyside and North Western Section. Riversdale Technical College, Liverpool. Wed., 4 Feb., 5.30 p.m.

Institute of Metals

LONDON
"Metallurgical Information," by B. Fullman. London Local Section. Thurs., 5 Feb., 6.30 p.m.*

Institute of Petroleum

LONDON
"Control of Marine Organisms in a Salt-Water Cooling System," by D. H. Tullis, L. C. Neill and A. T. Henderson. Wed., 4 Feb., 5.30 p.m.*

Institute of Refrigeration

LONDON
Thermoelectric Cooling," by Dr. H. J. Goldsmid. Institute of Marine Engineers, 76 Mark Lane, E.C.3. Thurs., 5 Feb., 5.30 p.m.*

Institute of Road Transport Engineers

BRISTOL
"From the Laboratory to the Road," by D. W. Bravey. Western Centre. Royal Hotel, Bistol. Wed., 4 Feb., 7 p.m.
GLASGOW
"Design of Radial-Flow Turbo-Chargers and Their Application to Road Transport and Public Service Vehicles," by E. Kellett. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Mon., 2 Feb., 7.30 p.m.
PETERBOROUGH
"Some Considerations Affecting the Selection and Use of Fuels and Lubricants for Road Transport," by C. E. Cook. Eastern Centre. Works of F. Perkins Ltd., Peterscourt, Midgate, Petercourt. Tues., 3 Feb., 7 p.m.

Institution of Chemical Engineers

BIRMINGHAM
Annual General Meeting. "Principles of Selecting Dimensional Systems and Units in Chemical Engineering," by A. Klinkenberg. Midlands Branch. Birmingham College of Technology, Gosta Green, Birmingham. Sat., 7 Feb., 2.30 p.m.
MANCHESTER
Discussion on "Effluent Disposal and Air Pollution." North Western Branch. Chemical Engineering Building, Manchester College of Science and Technology, Jackson Street, Manchester. Tues., 3 Feb., 3 p.m.

Institution of Civil Engineers

LONDON
"Preliminary Planning for the New Tube Railway Across London," by F. S. P. Turner. Tues., 3 Feb., 5.30 p.m.*
BRIGHTON
"Jodrell Bank Radio Telescope," by H. C. Husband. Southern Association. Brighton Technical College, Brighton. Thurs., 5 Feb., 6.30 p.m.*
MANCHESTER
Vernon-Harcourt Lecture on "Hydraulic Models," by F. H. Allen. North Western Association. Engineers' Club, Albert Square, Manchester. Thurs., 5 Feb., 6.30 p.m.

Institution of Electrical Engineers

LONDON
"Examples of Geoelectric Surveys," by Professor L. S. Palmer. Measurement and Control Section. Tues., 3 Feb., 5.30 p.m.*
"Turbo-Generator Performance under Exceptional Operating Conditions," by T. H. Mason, Dr. P. D. Aylett and F. H. Birch. Thurs., 5 Feb., 5.30 p.m.*
Discussion on "Problems of Storing Transient Phenomena for Subsequent Analysis," opened by Dr. P. Bauwens and P. Styles. Medical Electronics Discussion Group. Fri., 6 Feb., 6 p.m.*
BIRMINGHAM
Discussion on "Teaching of Electrical Network Theory," opened by Dr. D. G. Tucker and J. T. Allanson. South Midland Centre. James Watt Memorial Institute, Birmingham. Mon., 2 Feb., 6 p.m.*
CHESTER
"Electrification of the United Kingdom Atomic Energy Authority's Industrial Group Factories," by J. W. Binns and W. J. Outram. Joint Meeting of the North Western and Mersey and North Wales Centres. Town Hall, Chester. Mon., 2 Feb., 6.30 p.m.
GLASGOW
"Development of High-Voltage Air-Break Circuit-Breakers with Insulated-Steel-Plate Arc Chutes," by F. S. Fay and others. South West Scotland Sub-centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. Wed., 4 Feb., 7 p.m.
LEEDS
"Survey of Performance Criteria and Design Considerations in High-Quality Monitoring Loudspeakers," by D. E. L. Shorter. North Midland Centre. Offices of the Central Electricity Generating Board, Leeds. Tues., 3 Feb., 6.30 p.m.
MANCHESTER
"English Dialects," by Professor G. L. Brook. Fourteenth Annual Lecture. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 3 Feb., 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
Hugh Macmillan Memorial Lecture on "The Place of the Technologist in Management," by Viscount Simon. Tues., 3 Feb., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

LONDON
"Use of Plastics in the Heating and Ventilating Industry," by Dr. E. F. J. Tomalin. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, S.W.1. Wed., 4 Feb., 6 p.m.*
BIRMINGHAM
Discussion on "Oil Fuels: Their Storage and Application." Graduates' Evening. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Tues., 3 Feb., 6.30 p.m.
LEICESTER
Film Evening. East Midland Branch. College of Technology, Leicester. Wed., 4 Feb., 6.30 p.m.

Institution of Highway Engineers

LONDON
Discussion on "Land Acquisition." Institution of Structural Engineers, 11 Upper Belgrave Street, S.W.1. Fri., 6 Feb., 5.30 p.m.*
NORWICH
"Formwork Design and Construction for Concrete," by J. G. Richardson. East Anglia Branch. Assembly House, Theatre Street, Norwich. Wed., 4 Feb., 6.45 p.m.

Institution of Mechanical Engineers

LONDON
"An Experimental Investigation of the Pressurised Air-Lubricated Journal Bearing in the High-Speed Range," by N. F. Rieger. Lubrication Group. Tues., 3 Feb., 6 p.m.*
EDINBURGH
"The Management Control of Small Engineering Firms," by L. Fontaine, W. R. Spencer and J. M. Walker. Scottish Branch. North British Hotel, Edinburgh. Fri., 6 Feb., 6.30 p.m.
GLASGOW
"The Management Control of Small Engineering Firms," by L. Fontaine, W. R. Spencer and J. M. Walker. Scottish Branch. College of Science and Technology, Glasgow. Thurs., 5 Feb., 7.30 p.m.
MANCHESTER
"Some Metallurgical Problems in Nuclear Engineering," by R. Nichols. North Western Branch. Engineers' Club, Albert Square, Manchester. Thurs., 5 Feb., 6.45 p.m.

Institution of Production Engineers

DUNDEE
"Nylon for Engineers," by A. Clark. Dundee Section. Royal Hotel, Union Street, Dundee. Wed., 4 Feb., 7.30 p.m.
LETCHWORTH
"Product Management," by B. E. Stokes. Luton Section. North Herts Technical College, Letchworth, Herts. Tues., 3 Feb., 7.30 p.m.
NOTTINGHAM
"Application of Accurate Measurement to Production Engineering," by Professor J. Loxham. Nottingham Section. Reform Club, Victoria Street, Nottingham. Wed., 4 Feb., 7 p.m.

Institution of Public Health Engineers

LONDON
"Indeterminate Factors in the Design of Water Retaining and Underground Structures," by K. V. H. Smith. Caxton Hall, off Victoria Street, S.W.1. Mon., 2 Feb., 6 p.m.

Institution of Railway Signal Engineers

LONDON
"The Protection of Facing Points," by O. S. Nock. Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Wed., 4 Feb., 6 p.m.*

Institution of Rubber Industry

PRESTON
"Nylon and Rubber," by J. Buchan. Preston Section. Bull and Royal Hotel, Church Street, Preston. Mon., 2 Feb. 7.15 p.m.
SOUTHAMPTON
"Vinyl Chloride Polymers; Their Design and Application," by B. S. Dyer. Southern Section. Polygon Hotel, Southampton. Thurs., 5 Feb., 7.30 p.m.

Junior Institution of Engineers

LONDON
Various short films. Fri., 6 Feb., 7 p.m.*

Manchester Metallurgical Society

MANCHESTER
"Micro-Mechanism of Fracture," by Professor W. S. Owen. Central Library, Manchester. Wed., 4 Feb., 6.30 p.m.

Physical Society

FARNBOROUGH
Various short papers and demonstrations on "Visual Simulation of Flight." Optical Group. Royal Aircraft Establishment, Farnborough. Thurs., 5 Feb., 11 a.m. to 4 p.m. (approximately).

Reinforced Concrete Association

LIVERPOOL
"Foundations and Basement Construction," by G. A. Simpson. 9 The Temple, 24 Dale Street, Liverpool. Wed., 4 Feb., 6.30 p.m.*
MANCHESTER
"Foundations and Basement Construction," by G. A. Simpson. College of Technology, Sackville Street, Manchester. Tues., 3 Feb., 6.45 p.m.*

Royal Aeronautical Society

HATFIELD
First Halford Lecture at the Hatfield Branch, by J. L. P. Brodie. Hatfield Technical College, Hatfield. Thurs., 5 Feb., 6.15 p.m

Royal Institution

LONDON
"Microscopy with X-Rays," by Dr. V. E. Cosslett. Fri., 6 Feb., 9 p.m.

Royal Society

LONDON
"Exchange Interactions in Antiferromagnetic Salts of Iridium," by A. H. Cooke and others. Thurs., 5 Feb., 4.30 p.m.*

Royal Society of Arts

LONDON
"Mechanisation of Building Construction Processes," by Dr. D. G. R. Bonnell. Wed., 4 Feb., 2.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"The Production of Heavy Casting," by J. H. Pearce. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 3 Feb., 7 p.m.

Society of Engineers

LONDON
Presidential Address, by I. C. Cocking. Geological Society, Burlington House, Piccadilly, W.1. Mon., 2 Feb., 5.30 p.m.*

Society of Instrument Technology

SHEFFIELD
"Future of Solid State Electronics in Instruments," by H. Kemhadjian. South Yorkshire Section. The University, St. George's Square, Sheffield. Wed., 4 Feb., 7 p.m.

Television Society

LONDON
"Master Control Room Techniques," by B. Marsden. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2. Fri., 6 Feb., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1. (TATe Gallery 9371.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Engineers' Guild, 78 Buckingham Gate, London, S.W.1. (ABBey 7315.)
Helicopter Association of Great Britain, 4 The Sanctuary, London, S.W.1. (ABBey 5160.)
Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. (ABBey 5215.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave Square, London, S.W.1. (BELgravia 3291.)
Institute of Petroleum, 61 New Cavendish Street, London, W.1. (LANgham 3583.)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, E.C.4. (CENtral 4694.)
Institute of Road Transport Engineers, 69 Victoria Street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. (BELgrave 3647.)
Institution of Civil Engineers, Great George Street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria Street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria Street, London, S.W.1. (VICtoria 3017.)
Institution of Railway Signal Engineers. Apply to Mr. R. L. Weedon, 222 Marylebone Road, London, N.W.1. (AMBassador 7711.)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8. (BAYswater 9101.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1. (VICtoria 0786.)
Manchester Metallurgical Society, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
Physical Society, 1 Lowther Gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton Place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle Street, London, W.1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865.)
Society of Engineers, Abbey House, Victoria Street, London, S.W.1. (ABBey 7244.)
Society of Instrument Technology, 20 Queen Anne Street, London, W.1. (LANgham 4251.)
Television Society, 166 Shaftesbury Avenue, London, W.C.2. (TEMple Bar 3330.)

Design

THE ANALYSIS OF FLOW FROM PIPE MANIFOLDS

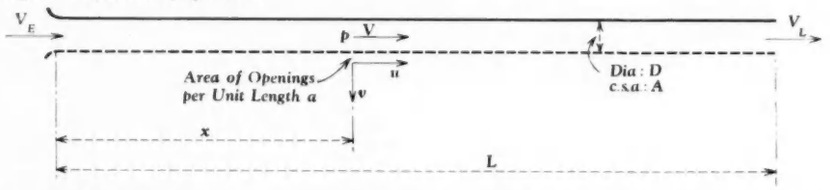
By Dr. E. MARKLAND, B.Sc., A.M.I.Mech.E., A.M.I.Struct.E.,

Department of Mechanical Engineering, University of Nottingham

The calculation of the distribution of flow from pipe manifolds of uniform cross-section, such as occur in water sprinkling installations or ventilating systems, has recently been discussed by Horlock.[1]

Fig. 1 denotes a manifold of length L and of circular cross-section of diameter D and area A, into which fluid of density ρ enters with velocity V_E at one end and leaves with velocity V_L at the other. Along the length of the manifold there are openings in the side through which the fluid may leave the manifold, and these are taken to be sufficiently numerous as to provide a continuous port along the length. Across a typical section at distance x from the inlet, conditions are assumed to be uniform, the longitudinal component of velocity being V and the static pressure being p in excess of the pressure outside the manifold. The local pipe friction factor is f, the area of the openings per unit length of pipe is a and their coefficient of contraction is C at this section. Fluid leaves the openings with velocity components u in the longitudinal direction and v in the normal direction.

Fig. 1 Definition of symbols.



The equation of continuity is

$$\frac{A}{dx}\frac{dV}{dx} + C\,a\,v = 0. \quad . \quad . \quad (1)$$

Writing, for brevity,

$$n \equiv \frac{C\,a}{A}. \quad . \quad . \quad . \quad (2)$$

$$\frac{dV}{dx} + n\,v = 0. \quad . \quad . \quad (3)$$

The equation of discharge through the ports is

$$p + \tfrac{1}{2}\rho V^2 = \tfrac{1}{2}\rho u^2 + \tfrac{1}{2}\rho v^2 + \text{losses} \quad . \quad (4)$$

so that, ignoring losses and assuming that the momentum in the longitudinal direction is unchanged as the fluid leaves the manifold, i.e., $u = V$,

$$p = \tfrac{1}{2}\rho v^2. \quad . \quad . \quad . \quad (5)$$

The equation of momentum is

$$\frac{1}{\rho}\frac{dp}{dx} + \frac{4f}{D}\frac{V^2}{2} + (2V - u)\frac{dV}{dx} = 0 \quad (6)$$

and again assuming that $u = V$,

$$\frac{1}{\rho}\frac{dp}{dx} + V\frac{dV}{dx} + \frac{4f}{D}\frac{V^2}{2} = 0. \quad . \quad (7)$$

Horlock showed that for a pipe manifold with a thin wall, the assumption that $u = V$ is fairly well substantiated by experiment. For a manifold discharging into lateral pipes which constrain the efflux to the normal direction, it would be more reasonable to assume $u = 0$. Equation (5) will remain unaltered provided that the loss at entry to the lateral pipes is taken to be $\frac{1}{2}\rho V^2$, but equation (7) will become

$$\frac{1}{\rho}\frac{dp}{dx} + 2V\frac{dV}{dx} + \frac{4f}{D}\frac{V^2}{2} = 0. \quad . \quad (8)$$

Equations (7) and (8) may be written in the common form

$$\frac{1}{\rho}\frac{dp}{dx} + \alpha V\frac{dV}{dx} + \frac{k}{n^2}V^2 = 0 \quad . \quad (9)$$

in which, for brevity,

$$\frac{k}{n^2} \equiv \frac{4f}{2D}. \quad . \quad . \quad (10)$$

and $\alpha = 1$ for a manifold discharging through open ports or $\alpha = 2$ for a manifold discharging into lateral pipes.

An equation for V may now be established by using equations (3) and (5) to eliminate $\frac{dp}{dx}$ from equation (9), and the result is

$$\frac{d^2V}{dx^2} + \alpha n^2 V - \frac{1}{n}\left(\frac{dn}{dx}\right)\left(\frac{dV}{dx}\right) + \frac{k\,V^2}{\frac{dV}{dx}} = 0. \quad (11)$$

If, in this differential equation, the usual finite-difference approximations to differential coefficients of V are made at a typical point 0 of the pipe (the notation being shown in Fig. 2), the result is:—

$$F_0 \equiv V_1 + V_3 - (2 - \alpha n_0^2 h^2)V_0 - \frac{h}{2n_0}\left(\frac{dn}{dx}\right)_0 (V_1 - V_3) + 2k_0 h^3 \frac{V_0^2}{V_1 - V_3} = 0. \quad . \quad . \quad . \quad (12)$$

Equations such as this have to be satified at each point of the pipe within the range $0 < x < L$, and a suitable method of obtaining a solution is by relaxation,[2] using equation (12) as a definition of residual at the typical point 0, the values of α, n_0, $(dn/dx)_0$ and k_0 being known at each point from the specified properties of the manifold.

Once the values of V and hence V/V_E at each point of the pipe have been found, values of v/V_E may be computed from the finite-difference form of equation (3), namely,

$$\frac{v_0}{V_E} = -\frac{1}{n\,L}\frac{(V_1/V_E) - (V_3/V_E)}{2\,(h/L)}. \quad (13)$$

The static pressure p and the total pressure P along the pipe may now be calculated from the relationships

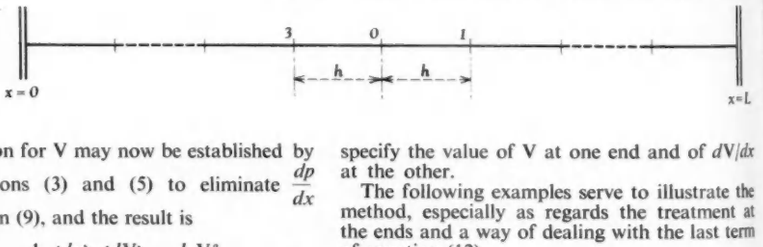
$$\frac{P_0}{P_E} = \frac{(V_0/V_E)^2}{1 + (v_E/V_E)^2}. \quad . \quad (14)$$

and

$$\frac{P_0}{P_E} = \frac{(v_0/V_E)^2 + (V_0/V_E)^2}{1 + (v_E/V_E)^2}. \quad . \quad (15)$$

It should be noted that the analysis is restricted by the condition that p shall be positive along the whole length of the manifold; if p becomes negative so that fluid flows into the manifold through the openings instead of out through them, equation (11) no longer applies. To obtain a relaxation solution it is necessary to specify the value of V at each end of the manifold or to specify the value of V at one end and of dV/dx at the other.

Fig. 2 Notation used in finite difference approximation.



The following examples serve to illustrate the method, especially as regards the treatment at the ends and a way of dealing with the last term of equation (12).

Example 1.—Manifold with negligible friction, uniform n

Since friction is negligible, $k = 0$, and since n is uniform along the length, $dn/dx = 0$, so equation (12) becomes

$$F_0 \equiv V_1 + V_3 - (2 - \alpha n^2 h^2)\,V_0 = 0. \quad (16)$$

Choosing, for a numerical example,

$$n = \frac{\pi}{2L},\ \alpha = 1,\ h = \frac{L}{8},\ V_E = 1,\ V_L = 0,$$

the residual at a typical point 0 becomes

$$F_0 \equiv V_1 + V_3 - 1{\cdot}96145\,V_0. \quad (17)$$

The solution, obtained by relaxation starting from an assumed linear decrease in V along the length of the manifold, is shown as V/V_E in Table I. The values of v/V_E, p/P_E and P/P_E derived by equations (13), (14), (15) are also shown.

TABLE 1.—*Manifold with Negligible Friction, Uniform n*

x/L	V/V_E	v/V_E	p/P_E	P/P_E
0·00	1·0000 (1·0000)	−0·002 (0·000)	0·000 (0·000)	1·000 (1·000)
0·125	0·9812 (0·9808)	0·192 (0·195)	0·037 (0·038)	1·000 (1·000)
0·25	0·9246 (0·9239)	0·379 (0·383)	0·144 (0·147)	0·999 (1·000)
0·375	0·8323 (0·8315)	0·552 (0·556)	0·304 (0·309)	0·997 (1·000)
0·50	0·7080 (0·7071)	0·703 (0·707)	0·494 (0·500)	0·995 (1·000)
0·625	0·5564 (0·5555)	0·827 (0·832)	0·684 (0·691)	0·993 (1·000)
0·75	0·3833 (0·3827)	0·919 (0·924)	0·845 (0·854)	0·992 (1·000)
0·875	0·1954 (0·1954)	0·976 (0·981)	0·953 (0·962)	0·991 (1·000)
1·00	0·0000 (0·0000)	0·995 (1·000)	0·990 (1·000)	0·990 (1·000)

Fig. 3 Relaxation patterns.

When carrying out the relaxation process it is advisable to use the approximate relaxation pattern shown in Fig. 3 (*a*) rather than that shown in Fig. 3 (*b*), which corresponds exactly with equation (17). The process is then simple and rapid, and although errors are accumulated as the calculation proceeds, these are revealed when residuals are checked and may be removed by further relaxation. Gradients of V at the ends of the pipe may be calculated by first finding values of V at points just outside the ends, which satisfy equation (17) at the end points. For example, at $x = 0$; $V_1 = 0{\cdot}9812$ and $V_0 = 1{\cdot}0000$ are already known.

To satisfy equation (17) at $x = 0$, $V_3 = 0{\cdot}9803$. Hence

$(V_1/V_E) - (V_3/V_E) = 0{\cdot}9812 - 0{\cdot}9803 = 0{\cdot}0009$.

There is a simple analytical solution to this example, namely,

$$\frac{V}{V_E} = \frac{\sin n(L - x)}{\sin nL}, \quad . \quad (18)$$

and values computed from this result are shown in parentheses in Table 1. It is seen that the error in the relaxation solution is quite small in this case, so that division of the manifold into eight intervals may reasonably be expected to give sufficient accuracy for practical purposes in cases where no analytical solution is possible.

Example 2.—Manifold with Friction, uniform n

Choosing, for a numerical example, the same data as used by Horlock, namely,

L = 4 ft, D = $\frac{3}{4}$ in, $a = \frac{3}{16}$ in dia. holes at 1 in centres, C = 0·61, $f = 0{\cdot}0047$, $\alpha = 1$, $V_E = 1$, $V_L = 0$, and $h = L/8 = 0{\cdot}5$ ft.

Then from equation (2) $n^2 = 0{\cdot}20931$ ft^{-2}, $\frac{dn}{dx} = 0$; and from equation (10) $k = 0{\cdot}03148$ ft^{-3}, so that the residual at a typical point 0 becomes, from equation (12),

$$F_0 \equiv V_1 + V_3 - 1{\cdot}94767V_0 + 0{\cdot}00787\frac{V_0^2}{V_1 - V_3} = 0 \quad . \quad . \quad . \quad (19)$$

The solution, obtained by relaxation starting from an assumed linear decrease in V along the length of the manifold, is shown in Table 2. The way in which the last term of equation (19) is dealt with is illustrated by Table 3. Starting with the linear assumption in column 1, the residuals shown in column 2 are calculated. These are liquidated using the approximate relaxation pattern of Fig. 3(*a*), i.e., ignoring, temporarily, changes in the last term. This relaxation leads to the second set of V values shown in column 3, from which a second set of residuals, shown in column 4, is calculated. Although these are not exactly zero because of the approximations in the relaxation pattern, they are generally smaller than the first set of residuals. The cycle is then repeated until the desired accuracy is obtained; after two further cycles the results of columns 7 and 8 are obtained, which cannot be improved substantially without introducing a further significant figure in the calculations.

The gradients of V at the ends of the pipe are obtained as previously. For example:

At $x = 0$, $V_1 = 0{\cdot}9235$ and $V_0 = 1{\cdot}0000$ are already known. To satisfy equation (19) at $x = 0$.

$$0{\cdot}9235 + V_3 - 1{\cdot}94767 + \frac{0{\cdot}00787}{0{\cdot}9235 - V_3} = 0.$$

The roots of this quadratic equation are

$$V_3 = 1{\cdot}0758,\ 0{\cdot}8718$$

and the former value is chosen since, in order to make v positive, dV/dx must be negative, i.e., V_3 must be larger than V_1.

TABLE 2.—*Manifold with Friction, uniform n*

x/L	V/V_E	v/V_E	p/P_E	P/P_E
0·00	1·0000	0·333	0·100	1·000
0·125	0·9235	0·348	0·109	0·877
0·25	0·8409	0·389	0·136	0·773
0·375	0·7455	0·457	0·188	0·688
0·50	0·6320	0·541	0·263	0·623
0·625	0·4981	0·627	0·354	0·578
0·75	0·3450	0·702	0·444	0·551
0·825	0·1768	0·754	0·512	0·540
1·07	0·0000	0·773	0·538	0·538

TABLE 3.—*Convergence Through Successive Cycles of Relaxation*

x/L	V	F	V	F	V	F	V	F
	1	2	3	4	5	6	7	8
0·00	100	—	100·0	—	100·0	—	100·0	—
0·125	87·5	2	94·0	−2·1	91·8	0·8	92·4	−0·1
0·25	75	2	86·0	−0·7	83·7	−0·1	84·1	0·1
0·375	62·5	2	76·0	0·8	74·3	0·0	74·6	−0·1
0·50	50	2	65·0	−0·9	63·1	−0·1	63·2	0·0
0·625	37·5	2	51·0	1·0	49·8	−0·1	49·8	0·0
0·75	25	1	36·0	−1·5	34·5	0·0	34·5	0·0
0·875	12·5	1	18·0	0·9	17·7	0·0	17·7	0·0
1·00	0	—	0·0	—	0·0	—	0·0	—

Example 3.—Manifold with Friction, Non-uniform n

Choosing, for a numerical example, a manifold in which L = 4 ft, D = $\frac{3}{4}$ in, $f = 0{\cdot}0047$, $\alpha = 1$, $V_E = 1$, $V_L = 0$, as in example 2, but in which the openings vary in size or spacing in such a way as to produce the distribution of n shown in column 1 of Table 4. The corresponding variation of dn/dx is shown in column 2. (This particular variation is intended to produce uniform discharge per unit length, and $p_E/P_E = 0{\cdot}100$.)

Then, choosing $h = L/8 = 0{\cdot}5$ ft, expressions for residuals at each point of the manifold may be written from equation (12). At $x = 2{\cdot}0$ ft, for example:

$n_0^2 = 0{\cdot}1225$ ft^{-2} $\qquad \left(\frac{dn}{dx}\right)_0 = -0{\cdot}0600$ ft^{-2}

$k_0 = 0{\cdot}01842$ ft^{-2}

So

$$F_0 \equiv V_1 + V_3 - 1{\cdot}96937V_0 + 0{\cdot}04286(V_1 - V_3) + 0{\cdot}00461\frac{V_0^2}{V_1 - V_3} = 0 \quad . \quad . \quad . \quad . \quad (20)$$

The relaxation solution and the results derived from it are shown in columns 3 to 6 of Table 4; the uniform rate of decrease of V along the manifold indicates a uniform discharge per unit length through the ports.

In this example the value of n or ca/A has been specified in terms of x, so it is presumed that both c and a/A are both known *a priori*. There is, however, some evidence that C varies[3, 4] with v/V, a ratio known only at the end of the calculation. Further experimental work is probably required to clarify this point, and if it becomes necessary to take into account such a variation in C, this would clearly be possible, although tedious, by successive cycles of calculation similar to that given above. In the same way variation of the friction factor f with Reynolds number could also be accommodated if necessary.

TABLE 4.—*Manifold with Friction, Non-uniform n*

x/L	n	dn/dx	V/V_E	v/V_E	p/P_E	P/P_E
	1	2	3	4	5	6
0·00	0·7500	−0·6723	1·0000	0·333	0·100	1·000
0·125	0·5416	−0·2633	0·8750	0·462	0·192	0·881
0·25	0·4442	−0·1443	0·7500	0·563	0·285	0·791
0·375	0·3870	−0·0904	0·6250	0·646	0·376	0·727
0·50	0·3500	−0·0600	0·5000	0·714	0·459	0·684
0·625	0·3253	−0·0400	0·3750	0·769	0·532	0·658
0·75	0·3092	−0·0251	0·2500	0·809	0·588	0·645
0·875	0·2998	−0·0125	0·1250	0·834	0·626	0·640
1·00	0·2967	0·0000	0·0000	0·843	0·639	0·639

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HYDRAULIC RELIEF VALVES

To provide hydraulic engineers with the basic data needed to design relief valves with a given performance, an analogue method is being developed by the Mechanical Engineering Research Laboratory.

A relief valve should open at a pre-set pressure; it should open as quickly as possible without imposing shock loads on the circuit; and it should not oscillate and cause noise while it is open. Tests on eight commercial valves showed that the circuit in which the valve is used has a very marked effect on its characteristics. Under the test conditions none of these valves met all the above requirements satisfactorily.

The method being tried out at MERL is to simulate electrically the characteristics of the components of a hydraulic circuit. For example, the orifice of a valve can be considered as a resistance, and the mass of fluid above the valve piston as an inductance. Calculations have been carried out for the electrical equivalent of a simple but typical circuit consisting of a supply tank, a positive-displacement pump, and a flow-control valve, with the relief valve between the pump and the control valve. The circuit equations indicate whether the valve is adequately damped and give the correct stroke for a given rate of flow; the response time of the circuit can also be derived.

Measurements on this type of hydraulic circuit have confirmed that the electrical analogy method gives valuable guidance to the designer. The method is being developed to cover more complex circuits. Further information is given in *MERL Fluids Note* No. 53, available from the Laboratory, East Kilbride, Glasgow.

Continuing **Design**

POWER *for Black Knight*

Details have now been released of the Armstrong Siddeley Gamma rocket engine which powered the first Black Knight re-entry test vehicle on its flight out of the earth's atmosphere on 7 September, 1958.

Towards the end of 1955, the Royal Aircraft Establishment initiated development of Black Knight, a re-entry test vehicle for which they had produced a preliminary design based on existing Gamma engine components developed by the RAE Rocket Propulsion Department at Westcott (now the Rocket Propulsion Establishment). In order to obtain adequate thrust for the vehicle, four Gamma units were required, and it was realised that with some modification they could be used to control the vehicle in a very simple manner. The RAE retained design authority and appointed Saunders-Roe Limited as the main contractor for the vehicle; and Saunders-Roe placed a contract with Armstrong Siddeley Motors Limited for the rocket engine.

In the Armstrong Siddeley Gamma engine the four combustion chambers are arranged uniformly around the central vehicle support, and are mounted on trunnions so that they may be rotated about axes that radiate from it. A hydraulic actuator, fitted to each chamber to control the angular movement, receives instruction from the guidance equipment. The vehicle is not intended to roll during flight and therefore two diametrically opposed chambers are rotated together to control pitch, and the other two to control yaw; to correct any tendency to roll, all four chambers are rotated in the same direction. Pitch and yaw are arbitrary terms for this vehicle because its flight path is almost vertical.

The combustion chamber trunnions are hollow, and through the inboard trunnion hydrogen peroxide (HTP) is pumped into the outer shell of the combustion chamber. To cool the inner shell, which contains the flame and would otherwise rise to 2,500° C, the HTP is passed through a clearance between the two shells before it enters a catalyst pack at the top of the chamber. This pack consists of silver plated nickel gauzes and in it the HTP is decomposed into a mixture of superheated steam and oxygen, with which kerosine ignites spontaneously.

The kerosine is fed into the chamber through its outboard trunnion and is admitted into the combustion chamber as soon as a pressure rise indicates decomposition of the HTP. Prior to this instant, nitrogen is blown through the fuel passages to prevent reaction in them between HTP and the incoming fuel. The nitrogen for this is obtained from a ground installation, which is disconnected automatically as the vehicle rises from the launcher pad.

Each combustion chamber is fed with propellants by its own turbo-pump unit, the four units being joined at the centre by a common HTP manifold to form a rigid cross which is attached to the structure of the vehicle at each of the fuel pump suction elbows. The centrifugal impellers of the HTP and fuel pumps are mounted at opposite ends of the same shaft as carries the turbine rotor. HTP decomposed in a separate catalyst pack provides a jet of hot gas which impinges on the axial flow turbine to drive the pumps. To start the engine HTP is supplied under pressure for this purpose from a ground installation which is disconnected automatically as the vehicle rises from the launcher pad. By this time the HTP pump pressure is high enough to supply the HTP for the turbine through a control valve.

The Gamma rocket engine controls Black Knight in pitch and yaw as well as providing propulsive effort.

Two of the turbo-pump units drive hydraulic pumps through kerosine-lubricated gear reduction units, and the engine compartment, which is supplied by Saunders-Roe, also carries a hydraulic reservoir and an accumulator. All the piping for this and all the electrical wiring in this compartment is fitted by Armstrong Siddeley because it is not possible to do so once the engine is installed.

The complete engine compartment weighs in the region of 700 lb. It is interesting to note that this weight is appreciably less than was anticipated during the initial design study for the vehicle, the weight saving having been effected without any additional development.

The total thrust of the engine is 16,400 lb at sea level, rising to nearly 19,000 lb outside the earth's atmosphere, due to the drop in back pressure.

Each engine is calibrated and tested at test houses at the Armstrong Siddeley Engineering Centre near Coventry before being dried out by a special process developed for this engine. A run of short duration is later carried out by Saunders-Roe when the vehicle is completed, after which the engine is again dried out before being flown to Australia. The reliability of the engine has been demonstrated by the fact that in no case has the engine failed to start and run when instructed to do so.

Research and Development

POLARISATION REVERSAL *in* FERRO-ELECTRICS

Recent experiments on single crystals of barium titanate have demonstrated for the first time that complete ferro-electric polarisation reversal can be obtained under an applied electric field, with a single expanding domain which grows through extensive sideways motion of the facing domain walls. These experiments were described in a paper, by Dr. Robert C. Miller of Bell Telephone Laboratories, New York, presented to the conference on the physics of dielectrics at Moscow late last year.

Very little work has been reported previously on sideways motion of 180° domain-walls in ferro-electrics. These domain walls are the boundaries between two adjacent areas, or domains, of opposite polarisation. Sidewise motion involves the movement of boundaries in a direction perpendicular to the dipole moment of the domain. In Dr. Miller's work, a single crystal of $BaTiO_3$ was mounted with liquid electrodes applied to both sides and subjected to an external applied field. The electrodes used were silver or platinum rods 1·0 mm in diameter, with a small hole drilled in one end. An aqueous lithium chloride solution, saturated at room temperature, was put in the hole as the electrolyte.

Partially switched crystals were studied by removing them from the apparatus and etching them for a short time in weak hydrofluoric acid. The positive dipole ends etched preferentially; examination with a microscope after etching allowed the domains to be observed visually. With the liquid electroded crystals, the number and size of the reversed domains in the partially switched crystals was of great interest. In numerous cases, a single reversed domain, comparable in size to the total electrode area, was observed. Many of the domains appeared to "nucleate" at crystalline imperfections.

In a further refinement of the technique, Dr. Miller took advantage of this phenomenon by "manufacturing" a nucleation site. The site was a sandblasted dimple about one-third the crystal thickness deep, and with a diameter about one-quarter that of the electrode. With such a dimpled sample in the liquid electrode holder, nucleation of reversed domains was most probable in the dimpled region because it was subjected to a high field compared to that of the surrounding area. Once a nucleation had occurred in the dimpled region, the domain grew out from the dimple through sidewise wall motion. The single domain was roughly square, as was shown by successive etching of the partially switched crystal. In this way, complete reversal of polarisation has been accomplished for the first time with a single expanding domain, starting from a predetermined point on the crystal.

There is some evidence to indicate that impurities have an effect on the velocity of the domain wall motion, but the evidence is meagre. These particular experiments indicate that the velocity is given by the equation:

$$v = v_\infty \, e^{\alpha/E}$$

for over three decades of velocity. The velocity for the field $E = \infty$ is v_∞, and is of the order of 10 cm per sec. The activation field varies from 2,000 to 4,000 volts per cm. It appears that under these conditions, this polarisation reversal is analogous to the magnetisation reversal found in some ferromagnetic materials.

Continuing **Research and Development**

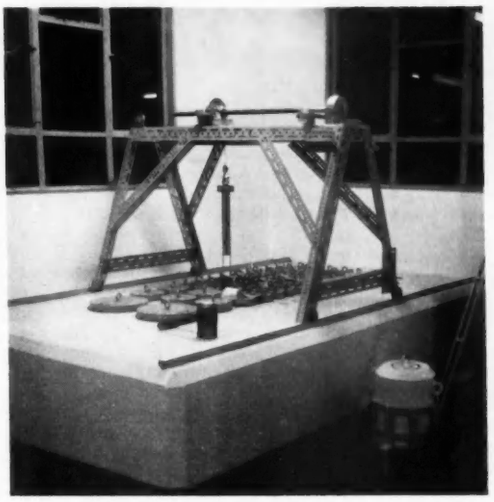
COMPANY'S RADIATION LABORATORY

ALTHOUGH 90 per cent of the work carried out at Isotope Developments Limited is concerned with electronics, the smooth running of the firm depends very much on the safe handling of radioactive materials. To this end the company have installed a new "active" laboratory in their works at Beenham Grange, Aldermaston Wharf, Berkshire. The laboratory provides safe storage and loading facilities for the radioactive sources used in conjunction with the industrial nucleonic instruments manufactured there. It also is used for tracer experiments using small quantities of "open" sources.

The radioactive sources are supplied by a department of the United Kingdom Atomic Energy Authority, who seal them and test them for leakage. Most of the sources have strengths in the millicurie range although smaller values are quite common and occasionally one curie sources are used. The gamma sources are mainly radiographic capsules, aluminium cased, and these are stored in a block of dense barytes concrete: a metal insert with a lead plug at the top carries an aluminium can containing the source to the bottom of one of a number of 2 ft holes in the block. About 10 curies of cobalt and 100 curies of caesium can be stored in this way.

Beta sources are usually in the form of metal foils—of sandwich construction, with the source in the centre—and are stored in a steel cabinet. Before being placed in the cabinet, the foils are shielded with Perspex, or lead, or by fitting them into a standard IDL source unit. Since there may be some residual radiation from the shielded sources, a $\frac{1}{2}$ in thick steel door is used for each compartment of the cabinet, and the top, back, and sides of the cabinet are lined with lead to ensure a safe level of residual radiation.

The new laboratory actually has three separate areas: the annexe, the source store, and the laboratory proper. The annexe acts as a "buffer" area between the parts of the laboratory where radioactive materials are handled, and the main part of the company's works. Entry to the laboratory is always made by way of it and protective clothing is kept there—to be put on by anyone entering the laboratory. The annexe also contains a stainless steel sink with drainage to a separate storage tank, for disposal of contaminated liquids. The floor of the whole building is covered with semi-tropical asphalt, with a non-absorbent surface, and the walls and ceiling are lined with plasterboard to give a ledge-free surface, painted with chlorinated rubber paint that can be washed down. Working surfaces are covered with a smooth plastic.



A block of concrete 2 ft thick is used to store the gamma sources. These are extracted by the gantry when required and transported in the pot shown on the right.

Within the laboratory proper are situated a concrete and lead loading cell for gamma sources, a Perspex shield for loading beta sources, and a fume cupboard. There is also a stainless steel sink that drains to the contaminated liquids storage tank. The loading cell provides shielding and remote handling facilities to enable gamma sources to be loaded into their holders. The main part of the cell is in concrete but a 4 in thick lead wall runs across the front and incorporates remote handling tongs and an 8 in thick lead glass window. A mirror mounted over the top of the cell gives a different viewpoint, ensuring that all parts of the cell are visible. Holders and sources are introduced into the working area through a port with a lead lined door across it to absorb radiation scattered from the concrete back and side walls of the cell. A radiation alarm gives warning of the presence of unshielded sources in the cell to ensure that the door is not inadvertently opened.

The Perspex shield is in the form of a large box with a partition dividing it into two. One side wall is equipped with remote handling tongs and the compartment they serve is used mainly for loading strontium foils. The other compartment merely has doors in its side and is used to load other foils such as thallium. A central compartment in the dividing wall provides shielding for the bulk supply of sources, while individual ones are being loaded.

The fume cupboard is mainly used for handling radium foils, and for some tracer experiments. It is fitted with an extraction fan protected by a filter. Other tracer experiments are carried out in a small Perspex glove box.

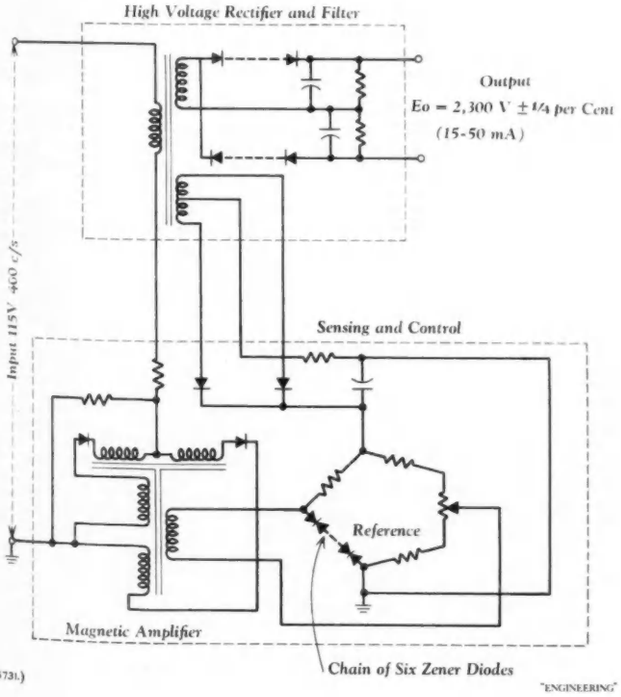
Within the store room a small gantry is used for extracting the sources from the concrete block. It can be seen in the illustration. When the sources have been drawn out of their 2 ft holes they can be handled by long tongs and placed in a carrying pot mounted on wheels. In the same room there is a bay for loaded source holders. The bay is constructed of interlocking concrete blocks and the holders are kept there until required for despatch.

REGULATED HIGH VOLTAGE SUPPLY

A magnetically regulated direct current power supply, capable of providing 2·3 kV at 15-50 mA has been developed at Bell Telephone Laboratories, 463 West Street, New York 14. A regulation of 0·25 per cent is achieved with the unit. An outstanding feature of the power supply is the isolation of the control and output sensing circuits from the high voltage output. This is accomplished by placing the control element—a self-saturating magnetic amplifier—on the low voltage input side of the regulated supply, and by adding an auxiliary winding for the output sensing. A conventional voltage doubler serves as the high voltage rectifier, with sufficient capacitance employed in the filter to reduce the r.m.s. ripple to 0·5 per cent at 50 mA. The reference voltage is provided by a series chain of six 6-volt temperature-compensated Zener diodes connected in a bridge circuit. Ruggedness and reliability are ensured by use of silicon rectifiers both in the high voltage output circuit and in the voltage reference circuit. The circuit diagram is shown alongside.

Both the control and the sensing circuits are isolated from the 2·3 kV output. A regulation of 0·25 per cent is achieved with the circuit shown.

Nominal input to the power supply is 115 V at 400 c/s. Output voltage is maintained to the desired accuracy with variations in line voltage from 105 to 130 V, with load current changes of 15 to 50 mA, and over an ambient temperature range of − 40° to + 85° C. Over a restricted temperature range, and with added refinements, it is claimed that the circuit has regulation capabilities of 0·1 per cent. Measured efficiency at full load is 82 per cent.



(8731.) "ENGINEERING"

Book Reviews

PHASE DIAGRAMS REVISED

Constitution of Binary Alloys. By MAX HANSEN and KURT ANDERKO. Second edition. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, N.Y., USA.* ($31·50); and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, E.C.4.* (252*s*)

To those metallurgists who have occasion to refer to a range of phase diagrams (and they form a substantial proportion of the profession) there is need to say little more than here is a new edition of "Hansen" and in English, too.

For others, perhaps a little more explanation is needed. Briefly, a phase diagram is a graph, in terms of composition and temperature, of the structures which any combination of the elements may possess at any temperature. This book considers only the combination of pairs of elements. However, such diagrams give basic information for a wide field of metallurgy. They give a first indication of whether a particular combination of elements is likely to be of technical use; of the possibility of test-treatment procedures and the temperatures required, and many other practical matters. They are also the basis for finding general rules of alloying behaviour, and much of the effort in the theoretical study of alloying is devoted to explaining the form of phase diagrams.

The original edition of this book, under the sole authorship of Dr. Hansen, was published in 1936, and soon became one of the classical books for metallurgists. With the increasing amount of original research on phase diagrams, particularly since the war, the earlier volume became seriously out of date. Although there have been a few publications since 1936 containing collections of binary phase diagrams, none have been as reliable or as useful as the original "Hansen." The publication of the present work is thus very welcome, and fills a major gap in metallurgical literature.

As in the first edition, the binary systems are dealt with in alphabetical order of the chemical symbols of the elements starting with silver-aluminium (Ag-Al) and ending with zinc-zirconium (Zn-Zr). For good measure an index is provided at the beginning of the book arranged in alphabetical order of the chemical symbols of the elements, and an index at the end of the book under the names of the elements. The literature on each binary system is reviewed briefly, but critically, and where the data are sufficient a phase diagram is given, which is usually a composite diagram based on a number of the references. The length of the discussion on any one system is much less than in the 1936 edition. Since far more systems are dealt with in the present edition, a full discussion of the data on each system as in the earlier edition would have made a prohibitively long volume. Most of the discussions in the present volume are not only brief, but very much to the point, and are models of the valuable but neglected art of inserting quarts into pint pots. This brevity is in some ways to be regretted; for it is no longer always possible to see the careful reasoning which led up to the final form of the diagram. As a result, more reliance must be placed on the authors' assessments of the original work, though there is no doubt that the authors' assessments are always reliable.

The discussion of each system is accompanied by a list of references. Comparison with other bibliographies shows that the reference lists are substantially complete, extended in many cases by references to unpublished work, theses and private reports which are not generally available to the metallurgical world. In all, about 9,800 references are cited.

A notable departure from the 1936 edition is that each diagram is drawn to a base of atomic per cent, with a non-linear weight per cent scale at the top. There is no doubt that this is scientifically the better method. Only the iron-carbon system is drawn to a linear base of weight per cent as well as to a linear base of atomic per cent. The conversion of atomic to weight per cent is made easy by tables at the end of the book, and conversion factors given at the head of each system. Furthermore, most of the compositions of critical points in the systems are given in both atomic and weight percentages in the diagrams and in the text. For those who still wish to use Fahrenheit degrees, a table is given for the interconversion of Centigrade and Fahrenheit temperature scales.

Crystallographic data is considered more fully in the present work, for in general both the symmetry of the phases and their lattice spacings are given. To assess the understanding of the crystallographic data, there is a table of crystal structure types according to *Struckturbricht*.

Comparison of the two editions of this work demonstrates how much more is now known of the constitution of binary alloys than in 1936. 1,382 systems with 750 diagrams are now considered compared with 828 systems and 456 diagrams in 1936. Many systems which were doubtful before are now firmly established. Exotic elements like plutonium which were unknown 22 years ago now find their place. However, this volume reveals that there is still much to be done. There are still many systems for which there are insufficient data for a diagram to be drawn; and many other diagrams are marred by question marks and dashed lines to indicate uncertainty. Perhaps 1980 will see a third edition of "Hansen" with these points clarified; but by then the task of the compilers will have become mountainous, rather than monumental.

"Hansen and Anderko" is undoubtedly destined, like its predecessor, to become a metallurgical classic. It is an accurate, convenient and critical assessment of an enormous amount of scattered data. It is up to date, for the literature has been covered up to the autumn of 1957. At 12 guineas the price is high, but so is the value; less than 2¼*d* a system, or 7*d* a diagram. It can be wholeheartedly recommended as *the* book on binary alloy systems.

Finally, the reviewer has only one slight regret. The original German edition first forced him, with many of his contemporaries, to acquire a smattering of scientific German, which has proved useful ever since. The present generation has now had this incentive removed.

D. W. WAKEMAN

The Reviewers

Dr. D. W. Wakeman is a member of the Institute of Metals and obtained his B.Sc. and Ph.D. in metallurgy at the University of Birmingham. He subsequently became lecturer in physical metallurgy at Sheffield University and is now group leader in physical metallurgy in the research laboratory of the Mond Nickel Company.

Dr. J. S. M. Botterill, who is a lecturer in the department of chemical engineering, University of Birmingham, obtained his B.Sc. in physics and his Ph.D. in chemical engineering; he is also an associate of the Institute of Physics and a member of the Society of Instrument Technology. He was formerly a scientific officer with the United Kingdom Atomic Energy Authority Industrial Group.

NEW BOOKS

Nomograms for Chemical Engineers. By O. P. KHARBANDA. *Heywood and Company Limited, Ingersoll House, 9 Kingsway, London, W.C.2.* (80*s*)

A collection from the published literature of some of the most useful nomograms, covering physical properties; unit operations; combustion; petroleum fractions properties; vessel design.

Quality of Surface Waters in Illinois. By T. E. LARSON and B. O. LARSON. Bulletin 45. *Department of Registration and Education, State of Illinois, Urbana, Ill., USA.*

The bulletin provides data on water quality in 19 streams at 21 sampling locations and at two locations on Crab Orchard Lake, the largest artificial lake in Illinois. It was prepared under the administrative direction of the Chief of the State Water Survey.

Air Conditioning and Refrigeration. By WILLIAM H. SEVERNS and JULIAN R. FELLOWS. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, N.Y., USA.* ($10·25); and *Chapman and Hall Limited, 37 Essex Street, London, W.C.2.* (82*s*)

The book is intended principally to cover American undergraduate courses in mechanical engineering and architecture, but it should be useful also as a reference volume to practising engineers. Based on the second edition of "Heating, Ventilating and Air Conditioning Fundamentals," by the same authors, the main emphasis now, as the title suggests, is on all the year round air conditioning and refrigeration. Very comprehensive examples and problems are included.

Rigid Frame Formulas. By A. KLEINLOGEL. *Crosby Lockwood and Son Limited, 26 Old Brompton Road, London, S.W.7.* (90*s*)

This second American edition is translated from the German 12th edition of the classic "Rahmenformeln." One hundred and fourteen different single span frame shapes are analysed for different loadings. Eleven frames of the earlier edition have been omitted in order to make space for eleven entirely new frame shapes.

Vehicle Headlamp Testing. Road Research Note No. 23. Department of Scientific and Industrial Research Road Research Laboratory. *Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.* (2*s*)

The note describes various types of headlamp and auxiliary lamp currently in use and outlines a suitable procedure for finding and correcting faults. It also describes types of beam testing equipment now available.

Electric Machinery. By CLIFFORD C. CARR. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, N.Y., USA.* ($9·25); and *Chapman and Hall Limited, 37 Essex Street, London, W.C.2.* (74*s*)

The author, who is head of the Department of Electrical Engineering of the Pratt Institute, Brooklyn, has been teaching the theory of direct-current and alternating-current as an integrated subject for many years. This book is a co-ordinated presentation developed from his teaching experience. Transformers, dynamos, polyphase synchronous machines, polyphase induction machines, d.c. machines and single-phase motors are covered.

The Analysis of Grid Frameworks and Related Structures. By ARNOLD W. HENDRY and LESLIE G. JAEGER. *Chatto and Windus Limited, 40-42 William IV Street, London, W.C.2.* (50*s*)

The modern practice of transporting very heavy loads by road has made it essential to have available an easily applied and accurate method of calculating the distribution of concentrated loads among the main girders of a highway bridge. This is one application of the theory of grid frameworks which is expounded in this book, intended for designers and advanced students. The method makes extensive use of harmonic analysis.

THROUGH A GLASS DARKLY

Atomic Physics and Human Knowledge. By NIELS BOHR. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, N.Y., USA.* ($3·95);† and *Chapman and Hall Limited, 37 Essex Street, London, W.C.2.* (32*s*)

The original province of physics was all knowledge about nature of which we ourselves are part. Gradually, the width of its scope has been narrowed to that of the study of the elementary laws describing the properties of inanimate matter. Even so, by the end of the 19th century the world seemed capable of a purely mechanical description. The subsequent development of the quantum theory in which Niels Bohr, Nobel Laureate, has played a significant part, has shown that the old conceptual mechanistic framework was far too inadequate to accept the necessary extension of description. This collection of seven essays prepared between 1932 and 1957 describes the basis for the revision of physical theory, and carries further the discussion of the implications of these developments to the theory of knowledge.

Bohr recalls how experience and the foundations of philosophy expected the stability of atomic structures, yet this required an intrinsic stability of the atomic structure which was at variance with our experience of natural mechanics and the classical theory of electrodynamics. Following Einstein's work on the photo-effect, he sought to resolve the contradiction by postulating that the electronic states in an atom were limited by some such quantum restriction. Physicists then became faced with two simultaneous, mutually exclusive yet complementary situations. Radiation appeared to have a corpuscular nature yet, from the well known interference effects, its wave character could not be disputed. Heisenberg, in his uncertainty principle, demonstrated the consequences of the postulated indivisibility of quantum phenomena. At the atomic level there is an interaction between the observed and the means of observation which inherently limits the information obtainable. The very foundation of a deterministic description disappeared and predictions, accurate though they be, have a statistical basis. In the limit, whether the wave or corpuscular character is observed is in the nature of the choice of experimental technique. These two are accepted as complementary situations which could not be described in the same terms but required two kinds of concepts. Bohr then in these essays considers possible broader aspects of " complementarity " beyond quantum physics.

The longest essay (35 pages), originally written as a contribution to a study of Albert Einstein, recollects discussions which they had had together. In these, Einstein was always reluctant to accept the principle of complementarity and constantly raised objections to it. He accepted that it contained nothing logically contradictory but he sought for a more complete conception which would not be so contrary to his scientific instinct. Each objection Bohr discounted.

The six other papers are particularly concerned with the implications of complementarity to the study of life. In their scope they cover much the same ground but there is some development of expression over 25 years.

Bohr reflects on the simplicity of physics compared with biology. He suggests that the notion of life is as elementary in biological science as the quantum of action is to physics. To investigate life in its finest detail would kill; here too is the interaction between the observed and the method of observation. From his father, a physiologist, he has an appreciation of the " purposiveness " of natural organisms and also of their wholeness. The conditions for the examination of the one of necessity excludes the other, for it is not possible to evaluate the possibilities of development and a detailed description of organic life simultaneously. Complementary language is again needed here to deal with different aspects of the same situation. In psychology we are aware that thinking alters the thought; the impossibility of distinguishing between phenomena themselves and their conscious perception. In the wider limit, there can be said to be the complementarity of culture. Within the one, justice and charity at the extreme are exclusive; a background of one culture interferes with our understanding of another.

Thus, within the frame of human knowledge and experience, Bohr finds much at unity with the startling implications of quantum physics. Einstein, however, was not willing to admit the limitation of complementarity to physics. The future will show " how dark is the glass through which we see."

J. S. M. BOTTERILL

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Construction

Filling Strip. THOS. W. WARD LTD., Albion Works, Sheffield. " Compri-Strip " is a foamed plastics bitumen impregnated material for use as a joint between panels, 'ambs, etc., as, for example, window frames and precast beams. Sizes from $\frac{3}{8}$ in by $\frac{3}{8}$ in up to $1\frac{5}{16}$ in by $3\frac{1}{2}$ in. Leaflet.

Air Coolers. A. F. CRAIG & CO. LTD., Caledonia Engineering Works, Paisley. Hudson Solo-aire heat exchangers using air as cooling fluid for oil refineries and chemical works. Also Combin-aire using either air or water. Brochure.

Car Parks. CEMENT & CONCRETE ASSOCIATION, 52 Grosvenor Gardens, London, S.W.1. Booklet entitled " Structural Concrete—Parking Garages " gives examples of such buildings the world over. One accommodates 72 cars on a ground site only 25 ft by 67 ft, using 18 floors. Others can take 3,000 cars at one time.

History. WHESSOE LTD., 25 Victoria Street, London, S.W.1. The story of the firm from the ironmongers' shop of 1790 to the present giant is told with many illustrations of Darlington and of the railway days, leading to examples of the modern chemical plant made by the company.

Self-energised Bucket. BLAW KNOX LTD., 94 Brompton Road, London, S.W.3. Concrete bucket, for use with crane, that provides its own power for opening the discharge gate. Four sizes from 3 to 8 cu. yards capacity. Remote control possible. Publication 270.

Sulphuric Acid Plants. SIMON-CARVES LTD., Cheadle Heath, Stockport. An 80-page book gives pictorial descriptions of acid plants together with operating circuits for the different processes and a section of technical data. The latter includes tables of Reich's tests, acidity tests, freezing points, vapour pressure, and the like.

Diggers. WHITLOCK BROS. LTD., Great Yeldham, Essex. Details of the Dinkum Digger Major and the Power shovel are given in illustrated folder.

Cooling Towers. FILM COOLING TOWERS (1925) LTD., Lionel Road, Kew Bridge, Brentford, Middlesex. Cooling towers, with natural or forced draught, and frame types are illustrated by examples; details of their construction and operation are given in 30 page brochure.

Pipe System. WELDING TECHNICAL SERVICES LTD., Hurst Mill, King's Norton, Birmingham 30. The Weltexa system of stainless steel piping is made up of standard units bolted together. Bends, straights, T's and reducers are included, in diameters up to 8 in bore. Booklet.

Chains. RENOLD CHAINS LTD., Renold House, Wythenshawe, Manchester. Examples of the use of chains in machinery for road and building works are given in a folder ref. 316/408.

On the Shelf

By Frank H. Smith

It is very difficult to get books on space travel that strike the happy medium of being neither science fiction nor abstruse volumes that only the initiated can understand. An exception is Monograph No. 6 of the Franklin Institute (Philadelphia, Pa.) which, entitled *Ten Steps into Space*, contains ten papers by authoritative American writers. Most aspects seem to be covered—history, the reaction principle, instrumentation, orbits, medicine, planetary atmosphere, fuels and, finally, prospects for the future. 202 pages cost but four dollars.

Heaven knows what this is doing in front of me but if anybody is interested in *plaques rectangulaires raidie par deux poutres de rive* (i.e., stiffened rectangular plates by two beams on each shore), there is an étude by Z. Hashin which is Cahier No. 7 de la recherche théoretique et expérimentale sur les matériaux et les structures published by Association française de recherches et d'essais sur les matériaux et les constructions, 12 rue Brancion, Paris XVe (as I've explained before—I get paid by the line). It is the first time these cahiers have crossed my path but if you want to know more, and about the other six, try Editions Eyrolles, 61 boulevard Saint Germain, Paris 5e.

I have reason to believe that this column is read by three people in the United States. As these outnumber my solitary English reader and my reader in the Federated Malay States by 300 per cent in each case, I have seriously thought of adopting the American idiom. But patriotism will out and I have decided instead to offer a free translation service to my United States readers. It works like this. If they come across a witticism or reference so subtle that it eludes them, if they will let me know I will try and get somebody to explain it to me and I will forward the translation at no cost to the inquirer. This does not include reverse telephone charge.

The Oxford Dictionary compilers have come up with a second list of " first references." This covers " alabamine " to " azurophil " and anybody interested should get in touch, as before, with the Editor, OED Supplement, 40 Walton Crescent, Oxford. The two samples I quoted are, of course, portmanteau words for Alabama baby mine and a blues lover.

When I was a cyclist I derived much delight from a slogan " Get your pleasure out of Dawes " —Dawes being a cycle manufacturer. Dawes—doors—out of doors—get it? Oh well. Anyway —this was all brought back to mind by the sight of *Dawe Digest*, the house journal of a different Dawe—this time Dawe Instruments Limited, 99 Uxbridge Road, London, W.5 (cue for song from Mr. Vaughan on " Green Door "). This is one of the more dedicated house journals with no funny stuff, and I gather that the Dawe concern busy themselves with electronic instruments. If you want to know what kinds I suggest you drop a card to 99-101 Uxbridge Road for the quarterly. A Mr. W. E. Mason is the editor.

If you fancy a socking great relief map to hang on your wall, write for details of their service to Canadian Aero Service Limited, 348 Queen Street, Ottawa 4. $45 for Europe 42 in by 48 in is a fair sample.

Those of you who find yourselves short of imagination when you want to describe your best friend or your worst enemy and those of you who wish to compete with Ivor Brown or Paul Jennings or Beachcomber may like to know that Penguin have reprinted their *Roget's Thesaurus* at 6*s*. It is reference book R.7. Each month, Penguin Books Limited (Harmondsworth, West Drayton) issue a list of their new books and reprints but unless you can withstand the temptation of buying books—however inexpensive they may be—I would not advise asking to be put on the mailing list.

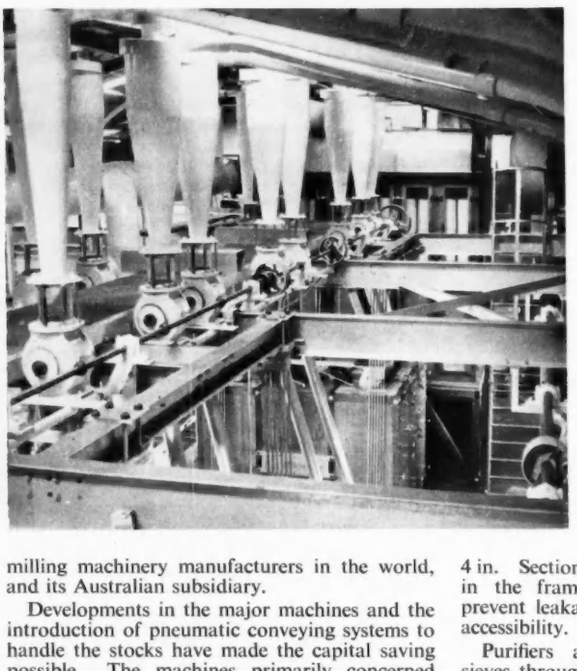
Production

PROCESS MACHINERY CUTS FLOUR MILL COSTS

Recent developments in flour milling machinery have made possible a new layout of flour mill which has just been started up by Barnes Milling Limited at Dalby in Queensland, Australia. The mill has only two floors, as against the conventional four or five floor building, and the actual floor space required has been cut by well over 50 per cent per unit of capacity.

The considerable saving in building and plant expenditure, which has enabled the operating company to cut the cost of their flour in the area by an initial 10*s* a ton, is the result of a combined operation by Thomas Robinson and Son Limited, Rochdale, one of the largest flour milling machinery manufacturers in the world, and its Australian subsidiary.

General view of the Dalby flour mill, showing the Robinson roller-mills below.



Cyclones for the high suction conveying system mounted in the roof.

Developments in the major machines and the introduction of pneumatic conveying systems to handle the stocks have made the capital saving possible. The machines primarily concerned are the rollermills, plansifters and purifiers.

Rollermills, which grind the wheat, were previously mounted on the first floor above a basement into which the wheat dropped by gravity to be raised by elevator for the next process. The drive was normally by lineshaft and belting from the basement. In the new Robinson machine, however, the stock is raised vertically through the rollermill by pneumatic suction, and the drive is by individual electric motor controlled from a central panel. A complete floor has thus been saved.

A new design of plansifter for grading the stocks has more than double the capacity of earlier machines. It consists of a robust covered framework suspended from canes with a gyratory mechanism giving a throw of 2½ in to 4 in. Sections of up to 24 sieve are enclosed in the framework which is tightly sealed to prevent leakage, with close-fitting doors for easy accessibility.

Purifiers are machines with reciprocating sieves through which air is drawn for purifying particles of semolina from the rollermills. By providing two layers of sieves instead of one the capacity is increased, and Robinson have also marketed a purifier which is, basically, two machines mounted one on top of the other, thus further increasing the capacity per unit of floor space.

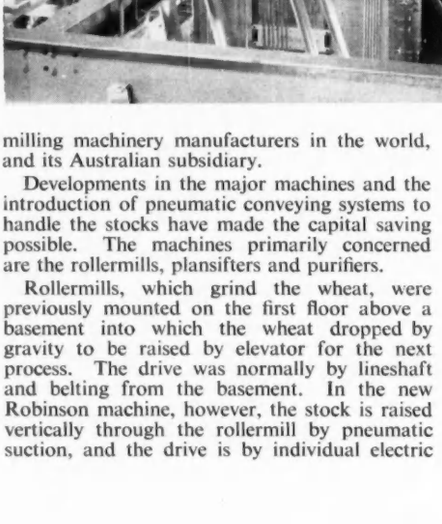
In addition to these machines the new plant includes a comprehensive wheat cleaning section prior to the milling process, the necessary ancillary machines and controls, and two pneumatic conveying systems.

One of these conveying systems, employed for conveying wheat in the cleaning section, is a positive blowing system, utilising two blowers, each of which gives two lifts, and is the first of its type in Australia. Wheat is lifted from the intake, or from machines on the ground floor, for gravity feeding through the cleaning machines on the platform.

The second system is employed for conveying stock through the actual milling process. Stock fed to the rollermills by gravity is picked up from hoppers in the machine and raised, by high suction, to cyclones which separate the stock conveyed from the air and feed it to the plansifters and purifiers mounted on the platform floor.

The mill's intake of bulk or bagged grain is received at the rate of 60 tons of wheat an hour in a large tipping hopper, the grain being automatically weighed, pre-cleaned and delivered into four 6,500 bushel silos before being fed to the cleaning section.

HANDLING PARAFFIN WAX



These two Megator pumps have steam and electric heating to prevent solidification of the wax passing through them.

Production of about a million candles a day by Price's Patent Candle Company Limited, Belmont Works, London, S.W.11, involves the handling of considerable quantities of paraffin wax, the principal raw material. Candle production does not, on the whole, lend itself to mechanisation, but wax preparation offers fewer difficulties, and a modernisation scheme recently completed at Price's has introduced improved methods of wax handling in place of the former steam-powered installation.

Paraffin wax is heated by open steam coils in 9 ton capacity tanks below the boiling house floor level, is filtered, and pumped to an overhead gallery of blending vats where sulphuric acid is added and the wax purified by steam agitation. From the vats the wax flows by gravity to the production section of the factory.

One of the problems in wax pumping is that the material is a poor conductor of heat and tends to solidify, which can cause complete blockage of the system. To prevent this all the pipelines are traced with heating cable to keep the temperature at 160° to 180° F. Heating equipment is also fitted to the two pumps which raise the wax to the blending vats. The pumps, which were supplied by Megator Pumps and Compressors Limited, 43 Berkeley Square, London, W.1, have external steam heating on the bases and internal electric heating tubes.

Vat replenishment occupies the pumps for two or three hours daily, when they operate at a rate of 9 tons per hr. Depending on the level in the tanks the conditions on the input side vary from gravity feed to slight suction lift. Heating is kept on whether the pumps are working or not, to ensure that the system is clear at all times.

Pumping and distribution of paraffin wax are controlled from a cabinet mounted directly above the pumps at main floor level. From this point it is possible to start and stop the pumps and to arrange the distribution to any one of three main vats.

EXHIBITIONS AND CONFERENCES

This list, in chronological order, appears in the last issue of each month. Events noticed for the first time and alterations of dates, places, etc., are indicated by an asterisk (*). For details of events not included below, reference should be made to ENGINEERING, *28 November, page 703, and 26 December, page 831. Organisers are invited to send particulars of coming events to the Editor.*

Brazilian Trade and Industry International Exhibition.—From Sat., 31 Jan., at Rio de Janeiro. To be held in two sections: that for Brazilian industry will open on 31 Jan.; opening date for the international section will probably be in March next; closing dates for the two sections not yet settled. Organisers: Ministerio do Trabalho, Industria e Comercio, Palacio Trabalho, Avenida Presidente A Carlos 251, Rio de Janeiro D.F., Brazil.

Montreal National Salon of Agriculture, Seventh.—In February, at the Show Mart, Montreal. Offices: 152 Notre Dame Street East, Montreal, Canada.

***Ancient and Modern Lamps, Exhibition.**—Sun., 1 Feb., to Fri., 1 May, at the National Museum of Wales, Cardiff. Apply to the Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. Tel. ABBey 5215.

Hardware Trades Fair, International.—Mon., 2 Feb., to Fri., 6 Feb., at Olympia, London, W.14. Organised by Universal Exhibitions, 74 Holland Park, London, W.11. Tel. PARk 7360.

Materials Handling in Canadian Industry, Exposition.—Mon., 2 Feb., to Fri., 6 Feb., at the Automotive Building, Toronto. Organised by *Materials Handling in Canadian Industry*, 2 Bloor Street East, Toronto 5, Canada.

Hotel and Restaurant Suppliers Exhibition.—Tues., 3 Feb., to Fri., 6 Feb., in the Show Mart Building, Montreal. Organised by the Hotel and Restaurant Suppliers Association Inc., 1638 Sherbrooke Street West, Montreal PQ, Canada.

IRON AND STEEL IN INDIA

Iron and Steel Industry in India, Symposium.—Wed., 4 Feb., to Sat., 7 Feb., at Jamshedpur. Organised by the National Metallurgical Laboratory, Jamshedpur 7, India.

New Building Materials and Techniques, Exhibition.—Fri. and Sat., 6 and 7 Feb., at the Royal York Hotel, Toronto. Organised by the Ontario Association of Architects, 50 Park Road, Toronto, Ont., Canada.

National Boat Show.—Fri., 6 Feb., to Sun., 15 Feb., in the International Amphitheatre, Chicago. Organised by the Outboard Boating Club of America, 307 North Michigan Avenue, Chicago, USA

***Commercial Vehicles Exhibition, 40th.**—Fri., 6 Feb., to Sun., 15 Feb., in Amsterdam. Organised by the Netherlands Cycle and Automobile Industry Association (RAI), 13 Delairessestraat, Amsterdam. (Additional information.)

Building Machinery and Contractors' Plant, Third International Fair for.—Sat., 7 Feb., to Sun., 15 Feb., at Basle. Apply to Dr. G. Kindhauser, c/o Brun & Co. A.-G., Nebikon, Lucerne, Switzerland.

Canadian Hardware Show, 54th Annual.—Mon., 9 Feb., to Thurs., 12 Feb., in the Canadian National Exhibition Grounds, Toronto. Organised by the Canadian Retail Hardware Association, 290 Merton Street, Toronto 7, Ontario, Canada.

Stationery Trade Fair, Fifth.—Mon., 9 Feb., to Fri., 13 Feb., at Alexandra Palace, London. Organised by the Stationers' Association of Great Britain and Ireland, 6 Wimpole Street, London, W.1. Tel. LANgham 9256.

Power Farming Conference, National.—Tues., 10 Feb., to Thurs., 12 Feb., at Harrogate. Theme: "Machinery and Men." Organised by *Practical Power Farmer* and the *Farmer and Stock Breeder*, Dorset House, Stamford Street, London, S.E.1. Tel. WATerloo 3333.

***Mass Transfer, Symposium on.**—Thurs., 12 Feb., at Church House, London, S.W.1. Organised by the Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. Tel. BELgravia 3647.

Agricultural Machinery and Equipment Exhibition, 39th International.—Sun., 15 Feb., to Sun., 22 Feb., at Brussels. Organised by the Société de Mécanique et d'Industrie Agricole, 29 Rue de Spa, Brussels 4, Belgium.

New Digital Computer Techniques, Specialist Discussion Meetings.—Mon. and Tues., 16 and 17 Feb., at the Institution's headquarters in London. Organised by the Measurement and Control Section of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. Tel. TEMple Bar 7676.

British Hosiery and Knitwear Exhibition.—Mon., 16 Feb., to Fri., 20 Feb., at Seymour Hall, London. Organised by Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1. Tel. GERrard 1622.

Toy Fair.—Mon., 16 Feb., to Fri., 20 Feb., at Brighton. Organised by the British Toy Manufacturers Association, 93-94 Hatton Garden, London, E.C.1. Tel. CHAncery 9158.

Stationery and Book Trades Fair, National.—Mon., 16 Feb., to Fri., 20 Feb., at the Royal Horticultural Society's Old and New Halls, Vincent Square and Greycoat Street, London, S.W.1. Organised by the *National Newsagent, Bookseller and Stationer*, 149 Fleet Street, London, E.C.4. Tel. CITy 2604.

Scottish Dairy Show.—Tues., 17 Feb., to Fri., 20 Feb., at the Kelvin Hall, Glasgow. Organised by the Glasgow Agricultural Society, 51 Moss Street, Paisley. Tel. Paisley 6244.

Alberta Motor Show.—Tues., 17 Feb., to Sun., 22 Feb., at the Jubilee Auditorium, Edmonton, Alberta. Organised by the Alberta Motor Show Committee, c/o Edmonton Symphony Society, Hudson's Bay Store, Jasper Avenue, Edmonton, Alberta, Canada.

Automotive Service Industries Show, International.—Wed., 18 Feb., to Sat., 21 Feb., at the Navy Pier, Chicago. Organisers: A. B. Coffman Associates, 28 East Jackson Boulevard, Chicago 4, Ill., USA.

Hoteliers, Caterers and Catering Equipment Exhibition, Second.—Wed., 18 Feb., to Fri., 27 Feb., at Bingley Hall, Birmingham. *Exhibition offices:* 71 Broad Street, Birmingham, 15. Tel. Midland 8073.

Practical Householder Exhibition.—Wed., 18 Feb., to Sat., 28 Feb., at Earl's Court, London, S.W.5. Organised by Trade Fairs and Promotions, Ltd., Drury House, Russell Street, London, W.C.2. Tel. TEMple Bar 3422.

RADIO AND ELECTRONICS

***Radio and Electronic Components Show, Second International.**—Fri., 20 Feb., to Tues., 24 Feb., in Paris. Organised by the Salon International des Fabricants de Piéces Detachées Radio et Electriques, 23 Rue de Lubeck, Paris 16e.

Miami International Boat Show, 18th Annual.—Fri., 20 Feb., to Wed., 25 Feb., at Miami. Offices: 615 S.W. Second Avenue, Miami 36, Florida, USA.

American Concrete Institute, Annual Convention.—Mon., 23 Feb., to Thurs., 26 Feb., at the Statler Hilton Hotel, Los Angeles, Calif., USA. Institute offices: P.O. Box 4754, Redford Station, Detroit 19, Mich., USA.

***Display Market Week, Second.**—Mon., 23 Feb., to Thurs., 26 Feb., at Russell Hotel, Russell Square, London, W.C.1. Organised by the National Display Equipment Association, 2 Caxton Street, London, S.W.1. Tel. ABBey 4813.

***Management in a Competitive World, Conference on.**—Thurs. and Fri., 26 and 27 Feb., at the Town Hall, Royal Leamington Spa. Being the 1959 Midland Management Conference of the British Institute of Management, 80 Fetter Lane, London, E.C.4. Tel. HOLborn 3456.

***Cycles, Motor Cycles and Camping Exhibition, 41st.**—Thurs., 26 Feb., to Sun., 8 Mar., in Amsterdam. Organised by the Netherlands Cycle and Automobile Industry Association (RAI) 13 Delairessestraat, Amsterdam. (Additional information.)

Melbourne International Trade Fair.—Thurs., 26 Feb., to Sat., 14 Mar., at the Exhibition Buildings, Melbourne. Organised by the Melbourne Chamber of Commerce, 422 Collins Street, Melbourne.

Israel Agricultural Exhibition.—In March, at the Beth Dagan Fair Grounds, Tel Aviv. Organised by the Israel Agricultural and Development Exhibitions Co., Ltd., 2 Carlebach Street, Tel Aviv, Israel.

***Television Equipment, Annual Exhibition.**—Tues., 3 Mar., to Thurs., 5 Mar., at the Royal Hotel, London, W.C.1. Organised by the Television Society, 166 Shaftesbury Avenue, London, W.C.2. Tel. TEMple Bar 3330.

UTRECHT FAIR

Utrecht International Spring Fair.—*Consumer Goods:* Mon., 9 Mar., to Sat., 14 Mar., at Utrecht, Holland. *Technical Fair:* Wed., 15 April, to Fri., 24 April, at Utrecht, Holland. Apply to Mr. W. Friedhoff, Netherlands Chamber of Commerce, 10 Gloucester Place, London, W.1. Tel. WELbeck 9971.

Philippine-British Trade Show.—Wed., 11 Mar., to Tues., 17 Mar., at the Manila Hotel, Manila. Apply to the Commercial Secretary, British Embassy, Hongkong and Shanghai Bank Building, Manila, Philippines.

Oil and Colour Chemists' Technical Exhibition.—Tues., 17 Mar., to Thurs., 19 Mar., at the Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1. Organised by the Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4. Tel. CENtral 2120.

Agricultural Machinery Exhibition, International.—Tues., 17 Mar., to Sun., 22 Mar., at the Exhibition Grounds, Porte de Versailles, Paris. Organised by the Union des Exposants de Machines et d'Outillage Agricoles, 95 Rue Saint Lazare, Paris 9e.

Concours Général Agricole.—Tues., 17 Mar., to Mon., 23 Mar., in Paris. Apply to the Commissariat du Concours Général Agricole, 72 Rue de Varenne, Paris 7e.

Witwatersrand Easter Show.—Tues., 17 Mar., to Mon., 30 Mar., at Milner Park, Johannesburg. Show incorporates a United Kingdom pavilion. Organised by the Witwatersrand Agricultural Society, P.O. Box 4344, Johannesburg, South Africa.

Radio Engineering Show.—Mon., 23 Mar., to Thurs., 26 Mar., at New York Coliseum, New York. Sponsored by the Institute of Radio Engineers. Organised by William C. Copp Associates, 72 West 45th Street, New York 22, USA.

***Institute of Physics: Stress Analysis Group's Easter Conference.**—Tues., 31 Mar., to Sat., 4 April, at the Technische Hogeschool, Delft, Netherlands. Institute's offices: 47 Belgrave Square, London, S.W.1. Tel. BELgravia 6111.

California International Trade Fair and Industrial Exposition, First.—Wed., 1 April, to Sun., 12 April, at the Great Western Exhibit Grounds, Los Angeles, California. Offices: P.O. Box 77610, Station D, Los Angeles 7, California, USA. *Agent:* Mr. M. Neven du Mont, 123 Pall Mall, London, S.W.1. Tel. WHItehall 8211.

***Audio Fair, Fourth.**—Thurs., 2 April, to Sun., 5 April, at the Waldorf Hotel, Aldwych, London, W.C.2. Organised by Audio Fairs Ltd., 42 Manchester Street, London, W.1. Tel. WELbeck 9111.

International Automobile Show.—Sat., 4 April, to Sun., 12 April, at the New York Coliseum, New York. Organised by the Charles Snitow Organization, Suite 1103, 331 Madison Avenue, New York 17, USA.

Radio and Electronic Component Show.—Mon., 6 April, to Thurs., 9 April, at Grosvenor House, and Park Lane House, London, W.1. Organised by the Radio and Electronic Component Manufacturers' Federation, 21 Tothill Street, London, S.W.1. Tel. ABBey 4226.

Factory Equipment Exhibition.—Tues., 7 April, to Fri., 17 April. Also the Heat and Sound Exhibition. Tues., 7 April to Fr., 14 April. Both to be held at Earl's Court, London, S.W.5. Organised by Factory Equipment Exhibitions Ltd., 4 Snow Hill, Holborn Viaduct, London, E.C.1. Tel. CENtral 0354.

***Swiss Industries Fair.**—Sat., 11 April, to Thurs., 23 April, at Basle, Switzerland. Apply to the Swiss Embassy, 18 Montagu Place, Bryanston Square, London, W.1. Tel. PADdington 0701.

PACKAGING

National Packaging Exposition, 28th.—Mon., 13 April, to Fri., 17 April, at the International Amphitheatre, Chicago. Organised by Clapp and Poliak Inc., 341 Madison Avenue, New York 17, USA.

Problems of Aircraft Production, Seventh Annual Conference.—Thurs. and Fri., 16 and 17 April, at The University, Southampton. Theme: "The Aircraft Industry—A National Asset." Promoted by the Southampton Section of the Institution of Production Engineers. IPE offices: 10 Chesterfield Street, London, W.1. Tel. GROsvenor 5254.

Industrial Photographic and Television Exhibition.—Mon., 20 April, to Fri., 24 April, at the Royal Albert Hall, Kensington Gore, London, S.W.7. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, W.C.2. Tel. TEMple Bar 3422.

Films in the Service of Industry, Second Festival.—Tues., 21 April, to Fri., 24 April, at Harrogate, Yorkshire. Apply to the organising secretary, Mr. R. T. Edom, 3 Portman Chambers, 7–9 Baker Street, London, W.1. Tel. WELbeck 1104.

Casablanca International Trade Fair, 15th.—Fri., 24 April, to Sun., 10 May, at Casablanca. Offices: Rue Jules Mauran, Casablanca.

***Royal Society of Health, Annual Congress.**—Mon., 27 April, to Fri., 1 May, at Harrogate. Society's offices: 90 Buckingham Palace Road, London, S.W.1. Tel. SLOane 5134.

***Liége International Fair.**—Sat., 25 April, to Sun., 10 May, at Liége, Belgium. *Agent:* Mr. R. C. Liebman, 178 Fleet Street, London, E.C.4. Tel. CITy 5889.

***Swedish Industries Fair, 42nd.**—Sat., 2 May, to Sun., 10 May, at Gothenburg, Sweden. *Agents:* John E. Buck and Co., Ltd., 47 Brewer Street, London, W.1. Tel. GERrard 7576.

***National Industrial Production Show of Canada.**—Mon., 4 May, to Fri., 8 May, in the Industrial Building, CNE Park, Toronto. Group display by British manufacturers, organised by the Board of Trade and the Birmingham Exchange and Engineering Centre. Offices of the Show: 19 Melinda Street, Toronto, Canada.

***Self-Service and Shop Equipment Exhibition, First.**—Mon., 11 May, to Fri., 15 May, at Olympia, London, W.14. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W.11. Tel. PARk 7360.

***Three Counties Agricultural Show.**—Tues., 16 June, to Thurs., 18 June, at Malvern. Offices: Malvern, Worcestershire. Tel. Malvern 2231.

***Helsingborg Annual Trade Fair (Expo Öresund).**—Fri., 5 June, to Sun., 14 June, at Helsingborg. Held in collaboration with the Swedish Federation of Commercial Agents. Apply to Helsingborg Exhibitions Co., Ltd., Helsingborg, Sweden.

***Building Plant Exhibition.**—Wed., 10 June, to Wed., 17 June, at Greenford, Middlesex. Apply to room 105A, Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611, ext. 1177.

Underground Machinery Manufacturers Council, Exhibition.—Thurs., 9 July, to Sat., 18 July, at Olympia, London, W.14. Sponsored by the Council of Underground Machinery Manufacturers, c/o Peat, Marwick, Mitchell and Co. (P.O. Box 121), 301 Glossop Road, Sheffield 10. Organised by the Municipal Agency, 70 Victoria Street, London, S.W.1. Tel. VICtoria 9132.

***Great Yorkshire Agricultural Show.**—Tues., 14 July, to Thurs., 16 July, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton Road, York.

***Radio and Television Exhibition, 26th National.**—Wed., 26 Aug., to Sat., 5 Sept., at Earl's Court, London, S.W.5. Pre-view Tues., 25 Aug. Organised by the Radio Industry Council, 59 Russell Square, London, W.C.1. Tel. MUSeum 6901.

***Handicrafts and Do-It-Yourself Exhibition.**—Thurs., 3 Sept., to Sat., 19 Sept., at Olympia, London, W.14. Offices: 24 Store Street, London, W.C.1. Tel. MUSeum 9792.

***Farnborough Flying Display and Exhibition.**—Mon., 7 Sept., to Sun., 13 Sept., at Farnborough, Hampshire. Open to the public on Fri., Sat. and Sun., 11, 12 and 13 Sept., only. Organised by the Society of British Aircraft Constructors, 29 King Street, London, S.W.1. Tel. TRAfalgar 3231.

***Food, Cooking and Catering Trades Exhibition.**—Tues., 8 Sept., to Sat., 19 Sept., at the City Hall, Manchester. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester 3. Tel. Deansgate 6363.

***Innsbruck Export and Samples Fair.**—Sat., 19 Sept., to Sun., 27 Sept., in Innsbruck. Information from British Austrian Chamber of Commerce, 29 Dorset Square, London, N.W.1. Tel. PADdington 7646.

AUTOMATION

***Instrument-Automation Conference and Exhibit, 14th.**—Mon., 21 Sept., to Fri., 25 Sept., at the International Amphitheatre, Chicago. Organised by the Instrument Society of America, 2443 South Hill Street, Los Angeles 17, Calif., USA.

***Building Research Studies and Documentation, First Congress of the International Council for (CIB).**—Mon., 21 Sept., to Fri., 25 Sept., in Rotterdam. Apply to the secretariat CIB, c/o Bouwcentrum, PO Box. 299, Rotterdam, Netherlands; or to the Building Research Station, Bucknolls Lane, Watford, Herts. Tel. Garston 4040.

***Magnetism, Conference on Some Aspects of.**—Tues., 22 Sept., to Thurs., 24 Sept., in Sheffield. Sponsored by the Institute of Physics, 47 Belgrave Square, London, S.W Tel. BELgravia 6111.

Perth Royal Agricultural Show.—Sat., 26 Sept., to Fri., 2 Oct., in Perth. Organised by the Royal Agricultural Society, 9 Howard Street, Perth, Western Australia.

***Watch and Jewellery Trade Fair, Fifth International.**—Mon., 28 Sept., to Fri., 2 Oct., at the Royal Albert Hall, Kensington Gore, London, S.W.7. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, W.C.2. Tel. TEMple Bar 3422.

SCIENTIFIC RESEARCH

***Scientific Research Exhibition, International.**—In October, at Olympia, London, W.14. To cover four main themes: Materials, Transport and Communications, Power and Industry, and Health and Food. Organised by International Scientific and Research Exhibitions Ltd., 34-35 Norfolk Street, London, W.C.2. Tel. COVent Garden 1411.

***Pacific International Trade Fair, First.**—Thurs., 1 Oct., to Sun., 18 Oct., at Lima, Peru Sponsored by the Peruvian Government. Organisers: Pacific International Trade Fair, PO Box 4900, Lima, Peru.

***Bakers' and Confectioners' Exhibition, International.**—Sat., 3 Oct., to Thurs., 8 Oct., at Olympia, London, W.14. Organised by Trades Markets and Exhibitions Ltd., 623 Grand Buildings, Trafalgar Square, London, W.C.2. Tel. WHItehall 1371.

Plastics Industry International Fair ("Kunststoffe 1959").—Sat., 17 Oct., to Sun., 25 Oct., at Düsseldorf. Organised by the Nordwestdeutsche Ausstellungs Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany.

International Clean Air Conference and Exhibition.—Tues., 20 Oct., to Fri., 23 Oct., in Seymour Hall, London. Organised, in celebration of its diamond jubilee, by the National Society for Clean Air, Palace Chambers, Bridge Street, London, S.W.1. Tel. TRAfalgar 6838.

***Motor Show (44th International Motor Exhibition).**—Wed., 21 Oct., to Sat., 31 Oct., at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders Ltd., 148 Piccadilly, London, W.1. Tel. GROsvenor 4040.

***Dairy Show, 73rd Annual.**—Tues., 27 Oct., to Fri., 30 Oct., at Olympia, London, W.14. Organised by the British Dairy Farmers' Association, 17 Devonshire Street, London, W.1. Tel. Langham 6903.

***Automation Congress and Exposition, Fifth International; and Second Military Automation Show.**—Mon., 16 Nov., to Fri., 20 Nov., at the New York Trade Show Building, New York. Organised by Richard Rimbach Associates, 845 Ridge Avenue, Pittsburgh 12, Pa., USA.

***Building Exhibition, 28th.**—Wed., 18 Nov., to Wed., 2 Dec., at Olympia, London, W.14. Offices: 11 Manchester Square, London, W.1. Tel. HUNter 1951.

Construction

HIGH VELOCITY AIR CONDITIONING PERMITS BUILDING ECONOMY

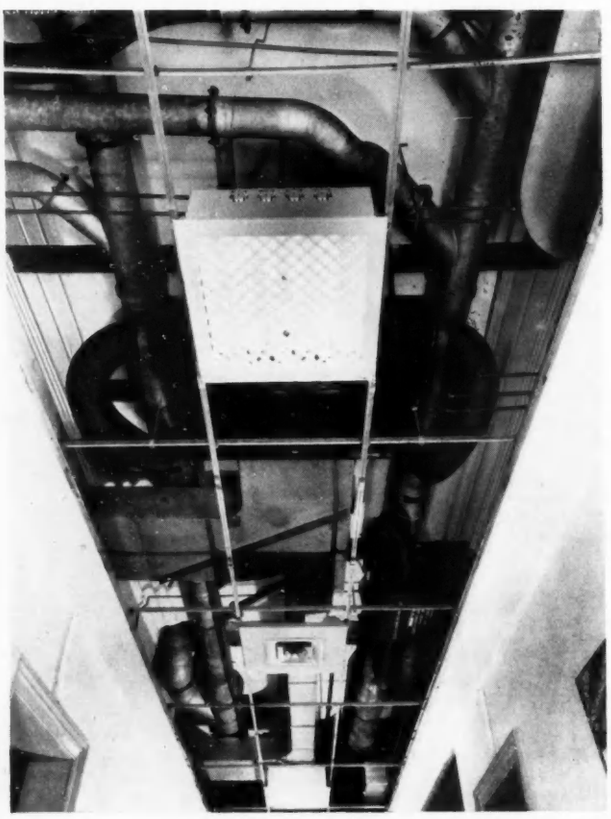
Noiseless Dual-Duct System now available

What is believed to be the first dual-duct high-velocity air conditioning system in the United Kingdom has been installed in the Newhall, Sheffield, offices of Brightside Heating and Engineering Company Limited. The installation was made for the purpose of developing and proving the system—in particular of suppressing the noise of the high-speed airflow—before making it commercially available. The system, demonstrated recently to the technical Press, is now working very satisfactorily, with no perceptible noise, and is providing very comfortable working conditions with individual control of temperature for each room.

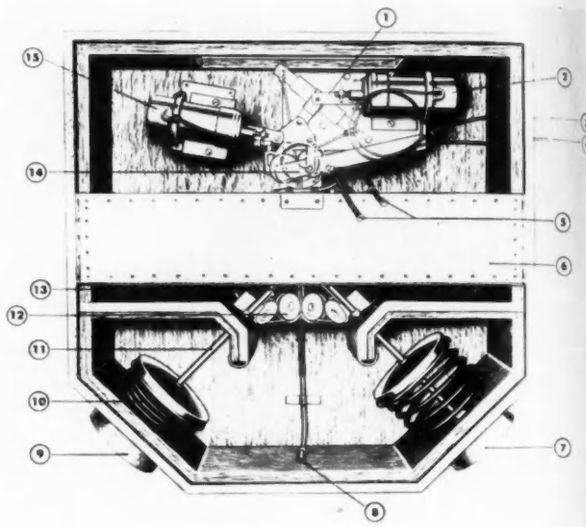
The high-velocity system—by which is meant a system involving air velocities of 6,000 to 8,000 ft per min,—is primarily of advantage in a large multi-storey building, and to reap this advantage the architect, structural designer and air conditioning engineer must co-operate from the earliest stages. The initial cost of the system is high, but it can effect economies in builders' costs, can provide a more compact air distribution system to suit modern architectural treatment, and can give greater comfort.

With the present conventional system applied to a typical multi-storey building, it is not at all unusual to have branch ducts on each floor of the order of 5 ft by 3 ft in cross section. These ducts are usually accommodated in the ceiling voids and add considerably to the building cost. The size of ducts has an important bearing on the final size of the building structure. The high velocity system makes possible a saving of 1 ft in height for each storey of the building, and could result in the provision of an additional floor in a 10-storey building for the same overall height. There is also a considerable saving from the reduced shaft sizes for the vertical duct risers.

For optimum comfort conditions, individual room temperature control during summer and winter has become an important requirement. In low-velocity systems, individual room control is expensive and difficult to obtain. Adjustments often unbalance the delicate equilibrium accomplished when the system is first installed and tested. With a high velocity system, on the other hand, individual room control is readily achieved without disturbing the balance of the rest of the installation.



Ceiling removed, showing the hot and cold ducts of the dual-duct high-velocity installation, the attenuation boxes, and the low-pressure distribution ductwork to the various rooms and ceiling diffusers.



Dual-duct mixing box showing acoustic treatment.

1. Linkage mechanism.
2. Temperature control motor.
3. To thermostat.
4. To main pneumatic supply.
5. Gauge connections for air delivery measurement.
6. Sinuous baffle.
7. Hot air inlet.
8. Pickup for pressure regulator.
9. Cold air inlet.
10. Neoprene coated helical spring damper.
11. Damper push rod.
12. Nylon pulleys.
13. Stainless steel aircraft type cable.
14. Pressure regulator.
15. Constant volume control motor.

The basic high-velocity systems are the single duct, using zone control, and the dual duct system, using a single fan having either zone control or individual room control. The single duct system is simpler and therefore less expensive. It is used for medium and small buildings, and sometimes in large buildings where the air conditioning specification is not stringent. In systems of this character, the fluctuation in temperature of the primary air supply related to the outside temperature is compensated for by overall zone control, and thereafter differences in individual room load and occupant preference are effected by simple manual damper control of the air volume at the distributing unit. In such a system it is necessary to have a pressure regulator in the main air supply so that the pressure within the system remains constant irrespective of the volume of air passing at any time. Controls can also be installed for the change over from winter to summer conditions.

The dual-duct single fan system, however, is the best all-purpose type of plant. In this, a central supply of both warm and cool air is conducted through two separate ducts to a mixing unit for each room. The total volume of air supplied to each room remains constant, but the proportion of warm to cool air entering the outlet is adjusted by a valve within the mixing box controlled from a room thermostat. This ensures precise control of room temperature with a quick response to any desired temperature alteration.

In large office buildings the air distribution system is usually divided into an interior zone and an exterior zone, depending on the orientation of the building. The exterior zones, where large glass areas are used, require additional heating or cooling, and it can be seen with this more complex application that high-velocity distribution of the air and its attendant high temperature differentials is of great advantage. Purpose-made window high-velocity units can be provided for this type of peri-

meteric distribution. With the equipment now being manufactured, where the air diffusing grilles to the conditional space are designed for 100 per cent induction of room air, temperature differentials for heat removal can be increased up to twice the conventional differential, thus reducing the initial air volume of the whole plant.

In Brightside's experimental installation, the comparative smallness of the building imposed some restrictions on the volumes of air that can be dealt with, but it was felt that an installation designed to handle 4,000 to 5,000 cu. ft per min would ensure that all problems within the medium and high velocity range (2,500 to 8,000 ft per min) could be investigated and resolved.

The main air handling equipment is installed adjacent to the office building and includes a single backward curved fan with a capacity of 4,600 cu. ft per min driven by an 8 h.p. motor. This propels the air at high velocity through two ducts in which the air is heated by batteries using high-pressure hot water from a central boiler plant. Under normal conditions when heat is required, the battery for the hot duct raises the air temperature to 130° F, and the battery in the cool duct tempers the air to 60° F; these heat requirements can be varied if necessary.

On the inlet side of the fan, a self-cleaning viscous air filter is fitted connected to the recirculation air system from the building and the fresh air inlet. Before the dual hot and cool ducts enter the office building, a length of noise attenuating duct is fitted to suppress mechanical noise from the plant.

The dual ducts pass, as far as possible, at high level in corridors and unused space, and provide conditioned air at high velocity and high pressure to a number of constant-volume high-velocity noise attenuating units. These units are installed at high level in the corridors, etc., and they are arranged to serve two drawing offices and a number of offices on three floors. The illustration (Fig. 2) shows one of these units. Each duct has a damper mechanism, and delivers into a common low-pressure plenum chamber with a sinuous type sound trap. Cold air enters through the left-hand tube, and hot air through the right-hand tube. Pneumatic damper motors actuate the dampers to control the proportion of hot and cold air delivery and the final temperature.

At the outlet, low-velocity air is discharged through a flanged opening connected to a short system of distribution ductwork fitted to 100 per cent induction-type grilles. These grilles are arranged in the walls of the various offices. In the entrance hall and corridor, the attenuation box outlets are directly connected to flush-fitting induction-type ceiling air diffusers, as shown in the illustration (see Fig. 1). The corridor ceilings, incidentally, are of the recently-introduced Braymex type with demountable expanded metal tiles.

The recirculation for the building consists of a central extract grille on each floor with louvres in the doors of the offices. (In a new building air recirculation would, of course, be arranged entirely through grilles built into the structure). The rate of air change is varied according to the occupancy of the various offices. The total space for which the plant caters is approximately 50,000 cu. ft, and all the rooms can be individually controlled between temperatures of 60° and 80° F.

Although no refrigeration plant is at present incorporated in the installation, it is intended to apply it to the top floor of the building. For this purpose it will only be necessary to connect pipe work from the refrigeration plant to the cool duct of the present system.

Metals and Materials

SPONGE IRON

The HyL process of direct reduction of iron ore into sponge iron is described in a new brochure published by M. W. Kellogg Company of New York, USA, which is based on operating data from a 200 ton per day plant in Monterrey, Mexico, owned and operated by Fierro Esponja, SA. Success with this plant implies that at least the major difficulties associated with the direct reduction of ore have either been overcome, or are not being encountered. Certainly in some circumstances the process could make a steel industry possible in parts of the world where hitherto it was not economically feasible because of lack of suitable coking coal required for the conventional blast furnace. The main difficulties with direct gaseous reduction are that the process takes a matter of hours, and that if the temperature is raised to increase the reaction rate, the whole mass of ore is likely to sinter and make removal from the reaction vessel impossible. The extent of sintering is dependent on the composition of the reducing gas and on the gangue in the ore, and the fact that no difficulty has apparently been encountered in the Mexican plant is probably a result of its making use of a high quality Durango hematite ore with an iron content of nearly 60 per cent and an insoluble content of only 5 per cent.

In the Fierro Esponja plant, the ore is reduced in fixed bed, batch type reactors with a gas which is approximately 85 per cent hydrogen and carbon monoxide and the remainder carbon dioxide, methane and water vapour, and which is obtained from natural gas. This gas is first desulphurised and then passed through a Kellogg high pressure steam reforming furnace. There are five reactors and the reduction cycle requires four hours with an additional 30 minutes for dumping and charging. In operation, ore ranging in size from $\frac{1}{4}$ to $1\frac{1}{2}$ in is charged into the reactors, each of which in the 200 ton per day plant holds about 30,000 lb of ore. Final reduction takes place within a temperature range of 1,600 to 1,900° F.

The final product retains the approximate size of the charged ore but becomes porous. The hot sponge iron is discharged from the reactor to a hopper for transportation to a direct arc melting furnace, and it is only at this point that separation of the iron from impurities takes place. With this particular Durango ore an oxide reduction of 95 per cent is attained, and the sponge iron contains about 85 per cent metallic iron, which, it is claimed, may be made with a carbon content between about $\frac{1}{2}$ and 2 per cent.

An estimate of the operating costs for a similar but much larger installation of 1,000 tons per day capacity has been made by the Kellogg Company, and their analysis of this is shown in the table. The low cost of operation stems mainly from the fact that the labour costs are low and that the reducing medium—natural gas—is available at practically negligible cost.

Operating Costs HyL Sponge Iron Process
Gulf Coast Area—1,000 T/D basis
Dollars per ton Fe

Iron ore (1·76 tons at 58 per cent Fe)	24·40
Gaseous reducing media	2·02
Fuel	1·47
Water	0·12
Steam	0·17
Boiler feed water	1·79
Power	0·08
Steam credit	−0·64
Fuel credit	−1·25
Labour	0·53
Total production Cost	29·23
Maintenance and capital charges at 20 per cent of plant cost	5·20
Total	34·43

EXTRUDED ALUMINIUM GRATING

Good corrosion resistance under marine conditions and high strength to weight ratio have earned aluminium a widespread application for gratings and treads used on ships. Until recently these were constructed from rods and bars and a type of riveting manufacture, but Archibald Low and Sons Limited, Glasgow, have made use of I-section extrusions from which to make an improved grating which they sell under the name of Alaflor. Panels are formed by welding together wide extrusions which have had square or rectangular holes punched from the flat central part of the I-section; with a span of up to 48 in Alaflor is available with a depth between $\frac{3}{4}$ in and 2 in, and in tread widths of 3, 4, 6 or 9 in. The manufacturers claim that the mode of construction gives high strength and quote the fact that an aluminium grating has only half the weight of the same area of a steel installation of equivalent strength.

Alaflor panels are fabricated by welding together I-section extrusions.

Continuing

Metals and Materials

POLYESTER DOUGH

DX18927 is a new fast-curing glass-fibre mineral-filled polyester dough moulding material which is produced by Bakelite Limited, 12 Hobart Place, London, S.W.1. The free flow characteristics and rapid cure of the dough enable components of relatively complicated design to be moulded by normal compression methods without breathing or chilling or long cures such as are often required with other glass-filled materials to prevent blistering. It combines excellent electrical properties with good water resistance, track resistance and dimensional stability, but is not quite as strong mechanically as more conventional alkyd or phenolic glass-fibre reinforced moulding materials. It is, however, cheaper to produce.

The material is recommended for applications where high mechanical strength is required and especially where the inherent properties of an alkyd moulding material would be an advantage, such as for contactor bases, switchgear components and insulators. In tests performed by Bakelite the following typical properties were obtained: impact strength, 2·5-4·0 ft-lb; tensile strength, 5,000-7,000 lb per sq. in; and a power factor at 800 c/s of 0·01-0·05 and at 10^6 c/s of 0·015-0·020. The company recommend a moulding temperature of about 150° C and a pressure not exceeding 1 ton per sq. in, under which conditions the cure on $\frac{1}{8}$ in sections takes about 1 minute, on $\frac{1}{4}$ in 5 minutes, and on 1 in 10 minutes.

RUSSIAN WELDING TRANSLATION

The British Welding Research Association is undertaking the cover-to-cover translation of the Russian *Avtomaticheskaya Svarka* (Automatic Welding). A start will be made with the January, 1959 number, which is expected to arrive in Britain in March, and to be ready for distribution to subscribers in May or late April.

Avtomaticheskaya Svarka is the only monthly journal in any language with the title "Automatic Welding," though it is fair to say that the field covered is far wider than the title would suggest. Equipment and methods of welding are dealt with, as well as metallurgy, the strength of welded work generally, and fatigue testing. The journal is about 12 years old, and was issued six times yearly until January, 1958 when it began to appear monthly. It is the organ of the Arc Welding Institute, the Institute being a section of the Ukrainian S.S.R. Academy of Sciences.

BWRA has arranged for the August, 1958, number to be translated as a specimen, and this will shortly be available on loan to anyone who writes to 29 Park Crescent, London,W.1. The subscription price will be £10 10s for the 12 issues of 1959. The contents of the August number are an editorial summary of the USSR seven-year plan (1958-1965) as it applies to welding, and 15 signed articles (three of them on electro-slag welding).

Engineering at Home

ELECTRIC RAZORS

There are many different types of electric razors on the market, involving a number of pros and cons of technique, speed, efficiency, and convenience. Since few of us can afford the time and expense of trying them all, the recent survey made by the Consumers Association, 7 Great James Street, London, W.C.1, will be of considerable general interest. The report is published in the current edition of *Which* and deals with all types of electric razors available in Britain.

In dealing with the respective efficiencies of the razors, the report shows that, contrary to general supposition, the thinnest blade guard does not necessarily give the closest shave—the design of the slots or holes being of equal importance in that it must allow the blades to come into direct contact with the skin. Also, the highest motor speed does not always mean the fastest shave, since the rate of cutting is proportional to the effective blade area as well as the speed. These points give a clear indication that the design of the blade guard is of major importance to the effectiveness of the razor.

Closely linked with the design of the guard is the cutting action of the blades, which may be rotary or reciprocating. However, it appears that neither action is intrinsically better and a preference for either can only be made in relation to the peculiarities of the user's hair growth and skin.

Interference with radio and television is one of the questions fully discussed in the CA report. Their findings reveal that very few brands are really offensive in this respect and about half of the razors investigated gave no interference at all. Noise was also measured, at 2 in from the razor, and the values recorded ranged evenly between 47 and 77 dB above quietness (60 dB 70 dB is considered loud and 80 dB very loud). The individual values bore no relation to the cost prices of the razors.

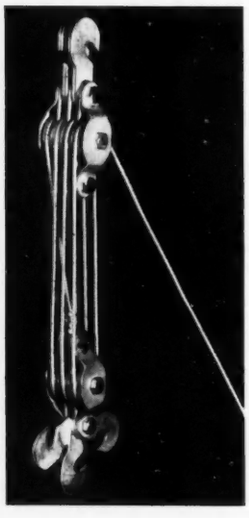
Safety from electric shock was thoroughly tested and particular attention paid to the possibility of bathroom vapours condensing on the razor and breaking down the insulation. All razors survived these tests.*

In their conclusions the CA stress the point that the manner of growth of the hair is the overriding factor in relation to the user's satisfaction with any particular razor, and they recommend that a two week "trial-period" system be adopted by the marketers so that the buyer can investigate for himself the best type and brand.

* Until recently the IEE regulations have forbidden any provision for portable electrical appliances in bathrooms. However, on 15 December, 1958, the Institution ammended the regulations to allow installation of electric razor sockets, provided certain specific standards and procedure are adopted.

EASY LIFTING

A hoist tested to lift over 1,000 lb is produced by Haltrac Limited, Weimar Street, London, S.W.15. The firm suggest that it is suitable for persons such as the home-owner, motorist, yachtsman and mountaineer. Weighing 1 lb, the Midget Hoist, as it is called, is made of aluminium and uses 72 ft of rot-proof nylon cord. The pulley wheels are of self-lubricating solid nylon. As is shown in the illustration, the load is evenly distributed over seven lines. The hooks act as a self-locking unit and can only be opened when the load is released.



Weighing only 1 lb, the hoist is suitable for lifting loads of 1,000 lb.

SUBSCRIBER TRUNK DIALLING

When Her Majesty the Queen opened the first subscriber trunk dialling (s.t.d.) installation at Bristol last month, there was a great deal of interest in the technical achievement behind the new service.

To give the full technical story of the scheme for complete automation of the telephone service in the United Kingdom, Mr. D. A. Barron, assistant engineer-in-chief of the Post Office, read a paper entitled "Subscriber Trunk Dialling" to the Institution of Electrical Engineers on 22 January.

In mentioning that over 320 million internal trunk calls were made in 1957 alone, Mr. Barron emphasised the immense complexity of allocating unique national numbers to each subscriber and establishing uniform charge rates.

The scheme has been arranged so that all calls will be timed and the "unit" fee reduced to 2*d*. The existing 3 minute minimum charge will no longer apply in s.t.d. areas, instead the number of unit fees will be recorded, each unit paying for a period of time which will be dependent upon the distance of the call. Both trunk and local units will be registered on subscribers' meters and a bulked bill will be rendered.

Private meters will be rented to subscribers who require them. The preparation of accounts is to be increasingly mechanised and in future accounts will be submitted quarterly instead of half-yearly.

By the end of 1961 it is expected that s.t.d. will be available in over 100 centres and by 1970 it is thought that 70 per cent of all trunk calls will be dialled by subscribers.

ENGINEERING

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